Buxtehude and the Meantone Organ
Developing an Analytical Approach to Music's Relationship to Temperament

BY

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Abstract

Inspired by Hans Davidsson's 2007 recording of the complete works of Dieterich Buxtehude (1637-1707) in quarter-comma meantone temperament, this document attempts to develop an analytical system that can illuminate various relationships between written music and temperament. Eleven of Buxtehude's praeludia, the scope of this project, are presented in a temporally driven graphic format. Data is extracted, individual and comparative analyses are made, and minor conclusions are drawn.

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Finally, I am forever indebted to my former teacher, Dr. Kola Owolabi, who has been an inspiration to me and is responsible for introducing me to the music of Buxtehude and of the seventeenth century. For his energy and love, I am eternally grateful.

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Introduction

Lighting the Fire: Hans Davidsson

Hans Davidsson's 2007 recording of Buxtehude's organ works marks a pivotal moment in the organ community. It is an influential recording that stands opposed to a resistance of historical temperament, and to the disbelief that music as adventurous as Buxtehude's could be played in a temperament as restrictive as meantone. Perhaps this recording stands as proof that meantone is not a restrictive system at all—that it can not only accommodate but even vitalize music as adventurous as Buxtehude's. Pieces that have been previously deemed unplayable are recorded, and, with some creative playing, they sound remarkable.

I was introduced to this recording before I understood the significance of any temperament. I fell in love with Davidsson's performances—his phrasing, articulations, and dynamics all contributed to the palpable drama he pulled out of the instrument. But, it was those howling, painful moments, which he somehow handled with elegance and grace, that captured my imagination. As I listened more, I became aware of the clarity and relaxation that came from the pure thirds, and the juxtaposition of this with such dissonance struck me. There is a musical energy that drives this music and if it is taken away from meantone, its potential is never fully realized—it remains stagnant.[1] It was, without a doubt, Davidsson's recordings that convinced me that keyboard temperament was linked more than circumstantially to music. I am far from the first to make this realization. Mark Lindley states,

> One might say that in different historical periods musical composition was sometimes deeply affected by the kind of tuning system operative at the time, as certain sonorous effects and certain melodic impulses were conditioned by virtue of the nuances of a particular style of tuning.[2]

[1] This is not to insinuate that Buxtehude should not be played in equal temperament, or even that those performances are not enjoyable.
[2] Mark Lindley, "Some Thoughts Concerning the Effects of Tuning on Selected Music Works (from Landini to Bach)," *Performance Practice Review* 9/1 (Spring 1996), 114.

This thesis is a modest attempt at developing a graphing system for music that could (1) illustrate and demonstrate a piece's tendencies within the boundaries of a temperament, in this case meantone, (2) yield a numerical system that could distill out as much data as possible in the simplest way possible, and (3) use music theory to provide an analytical tool for the greater field of musicology which has already provided considerable information to keyboard studies.

The following document will approach this topic in three main parts. Part One will provide a brief background and summary of related topics, particularly tuning and temperament as a wider discipline, and musicological research surrounding the temperament of organs that Buxtehude knew. Part Two will include some precedence for the development of a graphic representation, an explanation of the system itself, and some basic ideas for interpretation. Much of the material that belongs in this section has been removed and included in a series of appendices to avoid interrupting the flow of text with technical details. Finally, Part Three will include some individual analyses and a few modest conclusions or starting points.

Part I – Background

Tuning and Temperament: the Discipline

> The literature on tuning—both historical and current—is enormous in size and bewildering in variety. There are practical tuning instructions without a single technical term, table or figure. At the other end, there are mathematical treatises not comprehensible without a sound formal training in mathematical calculus and analysis.[3]

As Rudolf Rasch points out in his chapter-long survey of the topics, tuning and temperament are vast and can be difficult to coherently synthesize. That aside, his efforts are praiseworthy. In order to discuss the subtleties of meantone temperament, several working definitions should be established. First, tuning involves intervals that are just—that is, devoid of the acoustical phenomenon of beating. Temperament is a system of intentional, often methodical compromises to deal with discrepancies between different tunings. Though there are a myriad of tuning discrepancies to consider, the most often cited are the syntonic comma and the Pythagorean comma. The Pythagorean comma is the difference between twelve stacked purely tuned fifths and seven octaves. The syntonic comma is the difference between four stacked purely tuned fifths and two octaves plus a pure major third.[4] These fundamental shortcomings of the nature of pitch affected the development of Western music and led to centuries of theories involving temperaments.

The first discussion of meantone temperament is most commonly attributed to Pietro Aaron in his *Toscanello della musica* of 1522, but may also have been described by Arnolt Schlick in his *Spiegel der Orgelmacher und Organisten* of 1511.[5] Its date of origin may even

[3] Rudolf Rasch, "Tuning and Temperament," in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), 193–4.
[4] Ibid, 201.
[5] Ibid, 202.

extend as far back as 1482 with the writings of Barolomeo Ramis.[6] The credit for the first systematically described meantone temperament did not appear until Gioseffo Zarlino in his *Le istitutioni harmoniche* of 1558. The problem is that the temperament that Zarlino described is certainly not the same temperament that Schlick and Aaron described. The temperament described by Zarlino can be called 2/7 comma meantone while Schlick and Aaron are almost certainly describing quarter-comma meantone. To dissect this difference, some universal definition must be established.

This is not as easy as it should be due to some scholarly disagreement on the subject, albeit across generations. James Barbour describes meantone as specifically quarter-comma but acknowledges that different varieties do exist.[7] Mark Lindley defines,

> Meantone temperaments, in which the fifths and fourths are tempered rather more than in equal temperament so that the thirds and sixths will be only moderately tempered (indeed, the major 3rd may even be pure in one well-known form of meantone temperament), and the diatonic semitones are larger than the chromatic.[8]

Owen Jorgensen states,

> [Meantone] is sometimes understood to be the theoretically correct 1/4 comma meantone temperament by Pietro Aaron published in 1523. The broader usage of the term "meantone temperament" includes the infinite number of possible regular temperaments containing fifths that are from 1/3 to 1/7 syntonic comma narrower than just intonation fifths.[9]

[6] Ibo Ortgies, "Subsemitones in Organs Built between 1468 and 1721: Introduction and Commentary with an Annotated Catalog," in *GOArt Research Reports*, ed. Sverker Jullander (Göteborg, Sweden: GOArt Publications, 2003), 20.
[7] James Murray Barbour, *Tuning and Temperament: A Historical Survey* (East Lansing, MI: Michigan State Press, 1951), 25–44.
[8] Mark Lindley, *Lutes, Viols, and Temperaments* (Cambridge: Cambridge University Press, 1984), 2.
[9] Owen Jorgensen, *Tuning: Containing the Perfection of Eighteenth-century Temperament, the Lost Art of Nineteenth-century Temperament, and the Science of Equal Temperament, Complete with Instructions for Aural and Electronic Tuning* (East Lansing, MI: Michigan State University Press, 1991), 774.

Ross Duffin, still later, describes meantone temperaments as belonging to the same wider category of regular temperaments where fifths are tempered to be the same size, versus irregular temperaments where they are not.[10]

Regardless of subtle disagreements, it seems safe to say that meantone temperament is a broader category than one might suspect, even though one most frequently hears of quarter-comma meantone. This specific system involves equally reducing the size of each of the four fifths of the syntonic comma so that the resulting major third between the first and last pitch is acoustically pure.[11] Zarlino's system, then, involves fifths being diminished by 2/7, resulting in major thirds that are actually smaller than just. This results in all imperfect consonances being tempered by the same amount,[12] which would be useful in contemporaneous two-voice counterpoint.[13] Though this system eventually failed the test of time, due credit is given to Zarlino for being one of the first to systematically describe any variety of meantone. In summary, the fractions assigned to the different varieties of meantone describe the amount that all fifths in a given system are tempered compared to the syntonic comma. One can go as far as approximating equal temperament with a fraction of 1/11.

Since this document is not meant to serve as a subtle discussion of possible meantone temperaments, the description of meantone provided by Harold Vogel can function as a working definition,

> [Quarter-comma meantone] is characterized by eight pure major thirds (above E flat, B flat, F, C, G, D, A, and E), and eleven tempered fifths of a syntonic comma. (The syntonic comma—21.5 cents—is the difference from tuning four consecutive pure fifths (e.g., C-G-D-A-E).) This system results in four "wolf

[10] Ross Duffin, *How Equal Temperament Ruined Harmony (and Why You Should Care)* (New York, NY: W.W. Norton & Company, Inc., 2007), 38–9.
[11] Rasch, 202.
[12] Barbour states, "the major and minor thirds are 1/7 comma flat (3 cents), and the major and minor sixths are sharp by the same amount." However, it should read, the major thirds and minor sixths are 1/7 comma flat (3 cents), and the minor thirds and major sixths are sharp by the same amount. Barbour, 33.
[13] Barbour, 33.

> thirds" (above B, F sharp, C sharp, and G sharp) and a wolf fifth (G sharp to E flat), which renders it impossible to play B, F-sharp, C-sharp, and G-sharp-major, as well as G-sharp, E-flat, B-flat, and F-minor, chords.[14]

He derives this definition from Michael Praetorius's *Syntagma Musicum II: De Organographia*, though this is surely the same system described by Aaron and Schlick.

Historical Musings

The question prevalent to this document is: when Buxtehude was composing his free organ works, what temperament was in use, or what temperament did he have in mind? This is not at all to insinuate that the chorale-based works use some other system, but rather that this document does not consider those works. Eventually, most scholars seem to agree that it is likely that meantone—quarter-comma meantone to be precise—is the temperament that Buxtehude most often encountered. In the newer edition of her book *Dieterich Buxtehude: Organist in Lübeck*, Kerala Snyder asserts that this was likely the system in use at the *Marienkirche* in Lübeck during Buxtehude's tenure.[15] Most scholars, though some with reluctance, admit that meantone was even the dominant tuning system in the seventeenth century.[16] Mark Lindley has suggested that fairly strong evidence exists for meantone to have been in use as early as the fifteenth century.[17]

As soon as one decides that meantone is the temperament in use, one runs into some obvious problems: why are there so many notes in Buxtehude's output that are not possible in meantone? Snyder states,

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[14] Harald Vogel, "Tuning and Temperament in the North German School of the Seventeenth and Eighteenth Centuries," in *Charles Brenton Fisk: Organ Builder*, ed. Fenner Douglass, Owen Jander, and Barbara Owen (Westfield Center for Early Keyboard Studies, 1986), 238.
[15] Kerala J. Snyder, *Dieterich Buxtehude: Organist in Lübeck*, rev. ed. (Rochester, NY: University of Rochester Press, 2007), 82.
[16] Vogel, for instance, believes that modified meantone was a more prevalent.
[17] Mark Lindley, "Fifteenth-Century Evidence for Meantone Temperament," *Proceedings of the Royal Musical Association* (1975-1976), 37–51.

> Fewer than half of Buxtehude's organ works stay strictly within these limits, and a number of his most ambitious compositions, such as the praeludia in E Minor (BuxWV 142), D Major (BuxWV 139), and—most impossible of all—F-sharp Minor (BuxWV 146), make prominent use of pitch classes outside the system: D sharp, A sharp, A flat, and E sharp.[18]

Scholars have yet to make any firm conclusions about the tuning of either of the two *Marienkirche* organs. Snyder hypothesizes that Buxtehude's friendship with Andreas Werckmeister strongly influenced Buxtehude's reception of Werckmeister's circulating temperaments.[19] In circulating temperaments, intervals are altered at varying instead of regular amounts.[20] This may, at least in part, explain some of Buxtehude's more adventurous writing. She had even originally hypothesized based on church records that the tuning had been changed to Werckmeister III in 1683, but has since rescinded this argument given new evidence involving the work it would have taken to modify pipe length and payment for bellow treaders.[21]

There are several possible solutions to the clear dissonance between the tuning system and his organ works: (1) Some other temperament was used, perhaps a form of modified meantone; (2) Buxtehude had an organ with split keys (or subsemitones) in mind even though we know his organ lacked such keys; (3) the more adventurous works were theoretical works only; or (4) the more adventurous works were meant to be transposition exercises for students or models for improvisation.

(1) *Some other temperament was used, perhaps a form of modified meantone*: Harold Vogel very thoroughly argues that organs, more widespread than previously thought, had included various modifications to meantone temperament. Examples of a possible common modifications would involve raising the G sharp, allowing it to better function as an A flat, or

[18] Snyder, 84.
[19] Ibid.
[20] Rasch would call this a concentric tuning with the caveat that central (hence centric) fifths be emphasized. See Rasch, 215.
[21] Snyder, 84–5.

lowering the E flat, allowing it to better function as a D sharp.[22] Davidsson, on the other hand, states in clear opposition,

> Buxtehude's organ landscape was in quarter-comma meantone. Modification of meantone, either systematical or of practical nature with compromise notes, was, if and when applied[,] an exception to the general practice.[23]

This hypothesis would also contain any possibility that the organ was at some point retuned during Buxtehude's tenure, though this seems not to be the case.

(2) *Buxtehude had an organ with split keys (or subsemitones) in mind even though we know his organ lacked such keys*: Though subsemitones are not included on the *Marienkirche* organs, Buxtehude must surely have known organs that had split keys. Ibo Ortgies reveals,

> About eighty organs with thirteen-sixteen keys per octave are known today to have been built during the time period under discussion [1468-1721]. These instruments are, however, very likely only the tip of the iceberg, and a closer look into the literature and the archives might reveal many more examples.[24]

It is worth noting that, during the seventeenth century, one of these instruments was located in Lübeck and several more were in Hamburg, forty miles away.[25] Buxtehude was surely more than aware of the practice. The raised keys in question may have included with some regularity, G sharp/A flat, E flat/D sharp, and less regularly B flat/A sharp. As will be discussed later in greater detail, the inclusion of even one or two of these pitches makes the majority of the free works playable without significant issue. It is also worth noting that some combination of (1) and (2) could certainly be possible, given that they solve the same general problems.

(3) *The more adventurous works were theoretical works only*: It is possible that the harmonic exploration in some of the more adventurous praeludia may have been part of pieces

[22] Vogel, 238–9.
[23] Hans Davidsson. *Dieterich Buxtehude and the Mean-Tone Organ*. Recorded 2006. Loft Recordings, 2007, Liner Notes, 13.
[24] Ortgies, 37.
[25] Buxtehude's regular excursions to Hamburg are outlined in Snyder, 107–134.

intended as theoretical compositions. Aside from writing organ works far in excess of his contracted responsibility, there are 114 extant vocal works, none of which were required compositions by contract.[26] The majority of the organ works could have been liturgical in some way, but Synder says "certainly extensive solo performances such as are represented by his *pedaliter* praeludia and chorale fantasias did not belong to Buxtehude's official duties as organist."[27] It is interesting to note that more than two thirds of Buxtehude's free organ works with pedal survive through the Bach circle[28]—it remains to be seen exactly what this may enlighten, other than they were obviously valued.[29] As an organist, it is tempting to discount this option solely based on the pieces' "performability," but one would have no solid grounding to do so.

(4) *The more adventurous works were meant to be transposition exercises for students or models for improvisation*: The strongest evidence for this argument probably comes from the fact that the art of this particular genre of free work is definitely improvisatory. It is abnormal that so many works of an improvisatory tradition survive in written format at all.[30] Snyder summarizes the work of Ibo Ortgies and Sigbert Rampe, "Buxtehude did not write these pieces down with the intention of playing them on the organ, but rather to use them as models in the teaching of improvisation and composition, which was done not in the church but at a stringed keyboard

[26] However, there may be other very legitimate explanations for all the compositions. See Snyder, 97.
[27] Ibid, 100.
[28] Meaning that two thirds of his works exist in copies by Bach, his friends, family, students, students of students, etc.
[29] Ibid, 106.
[30] Snyder, 228.

instrument in the teacher's home."[31] Furthermore, some pieces, even if the tuning were to be adjusted, would still be unplayable due to the short octave.[32]

Ortgies demonstrates that subsemitones were primarily needed for transposition to accompany instrumentalists,[33] so it is possible that transposition exercises were given to beginning organ students.[34] One problem with the transposition hypothesis is that some works still contain significant tuning issues even after being transposed. Vogel states,

> Several other free works, such as the Praeludium in E Minor (BuxWV 142) of Buxtehude, which can only be performed in well-tempered tuning—even when transposed to a meantone key—are possibly later reworkings of compositions which originally did not exceed the boundaries of meantone's seventeen triads.[35]

Vogel's Solutions

Harold Vogel accounts for the various problems encountered when using meantone for Buxtehude's organ works with six different categories. In theory, each piece should fit into one of the categories in Figure 1, taken from Vogel.

Figure 1: Division of North German Repertoire (quoted from Vogel, 1986)[36]

1) Meantone - pure or slightly modified (M. Praetorius)	Compositions which do not exceed the meantone boundaries (eight major thirds [in a chain of fifths] from E flat to E and nine minor thirds [in a chain of fifths] from C to G sharp).
2) Expanded meantone - using sub-semitones	Compositions which make use of sub-semitones (usually D sharp and A flat, only rarely A sharp and D flat).
3) Expanded meantone - modified (Scheidemann/J. Praetorius)	Compositions which exceed the meantone boundaries by using the major third B to D sharp and the minor third F to A flat.

[31] Ibid, 229.
[32] A short octave affects the bottom octave of certain keyboard instruments. These instruments contain fewer than the standard eleven pitches, thus conserving space. The idea is that most compositions do not need the lower chromatic pitches such as C sharp, E flat, etc. There are regional and builder specific variances.
[33] Ortgies, 25.
[34] There seems to be a disconnect between a transposition exercise and a praeludium. Composing the F-sharp minor, for instance, seems to be a rather excessive exercise. Partimenti-like short compositions, brief improvisations, and transpositional exercises surely would have sufficed for students.
[35] Vogel, 247.
[36] Vogel, 246.

4) Expanded meantone-Transposition	Compositions which do not exceed the meantone boundaries of seventeen thirds (eight major and nine minor), but move about in the circle of fifths; that is, pieces which, if transposed, could be played in the normal meantone framework.
5) Expanded meantone - using strong dissonances	Compositions which exceed the boundaries of meantone temperament only to exploit the "shock value" of some dissonances (B to D sharp, F sharp to A sharp, A flat to C, D flat to F, or F to A flat).
6) Well-tempered	Compositions whose modulations regularly exceed the boundaries of meantone temperament, and, by making regular use of complicated seventh chords, require a well-tempered tuning.

Though I am less prepared to argue with Vogel's general categorizations, I hesitate less to emphasize his fifth category more than he seems willing. In describing this category, he states, "the fifth group contains only a few compositions, such as the Praeludium in F Major (BuxWV 145, mm. 20 to 21) and the Toccata in F Major (BuxWV 156, mm. 83 to 88) of Buxtehude"[37] This seems like a premature assertion, since the cited measures in BuxWV 145 contain less "shock value" than other measures in the same piece, such as m. 125. Furthermore, they certainly contain less shock value than measures in BuxWV 136 and 137, both of which he would have assigned to the third category. If those pieces were to be assigned to the third category, one has to ask on what grounds would one have for arguing that pieces containing fewer instances of A flat and D sharp would have been composed with a completely different tuning system in mind. If nothing else, categorizing the pieces so readily in such different contexts leaves something to be desired. His categorizations must be used somewhat arbitrarily thus implying, at least in part, that each organ work was composed in a completely different context—for example, one as organ teacher, another as church organist in Lübeck, and still another as organ composer

[37] Vogel, 247.

imagining the use of split keys or modified temperament somewhere other than his church—something that is surely not the case.[38]

Conclusions: Adding a Voice

> The sources dealing with tuning and temperament are sufficient to provide an overview of the subject. And the richest source of information is not archival evidence and the writings of the theorists but is, rather, the original pipework from surviving antique instruments.[39]

It seems that somewhat recent scholarship has taken into account two large bodies of information: archival evidence and extant instruments. The obvious lacking piece of information excluded from consideration is just as reliable as either of the other sources—the music itself. Notably, both Vogel and Snyder discuss musical examples at length.[40] On the other hand, neither seems to be willing to take the plunge and look beyond a few stray or renegade pitches. I hope that the rest of this document can serve as a starting point for adding a third voice into the conversation. I hope that this theory, like so many others, might later be used to enlighten larger areas of musicology.

[38] Chronology of the organ works (which is unavailable) would also certainly be a factor if Buxtehude's relationship to Werckmeister did play a part in Buxtehude's conception of temperament. Chronology would also be a factor if the instruments were ever retuned.
[39] Vogel, 237.
[40] See particularly Vogel's elegant explanation of single manual subsemitones. See Vogel, 240.

Part II – An Analytical Approach

Before discussing the aforementioned graphing system and its possible interpretations, some precedence for such a system will be acknowledged and the project's confines and boundaries will be established.

Contextualization

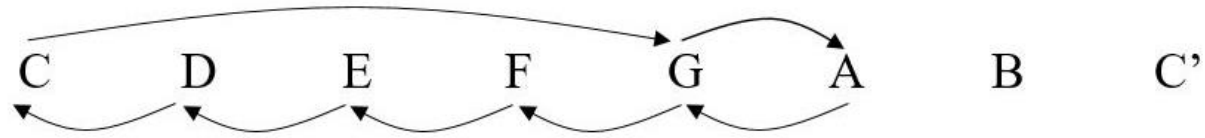
Analysis of musical information through geometrical representation is a common tool of theorists.[41] David Lewin coins two terms for music theorists that are helpful in contextualizing the following graphic approach: figural versus formal layouts.[42] He likens his figural approach to that of a "blow-by-blow" analysis that he states, "is common in the essays of enthusiastic music students at an early stage of their technical training,"[43] or more significantly, "in certain studies by sophisticated musical scholars, studies influenced by recent literary theories of narrativity."[44] Figural representation exemplifies a piece's journey in time. Perhaps this is so common for young students since Lewin's other layout requires an intellectual jump away from the music's inherent temporal flow.[45] Formal layout, then, attempts to represent an out-of-time musical structure. Formal analyses are intellectual leaps, but have been used to uncover otherwise hidden functions underlain in music. Lewin derives these two types of geometric representation from a

[41] Catherine Nolan, "Music Theory and Mathematics," in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), 280–284 (Section on Geometry). More recently, Dmitri Tymoczko, *A Geometry of Music: Harmony and Counterpoint in the Extended Common Practice* (Oxford: Oxford University Press, 2011), and Godfried T. Toussaint, *The Geometry of Musical Rhythm* (London: CRC Press Inc., 2013).
[42] David Lewin, "Making and Using a Pcset Network for Stockhausen's Klavierstücke III," in *Musical Form and Transformation: 4 Analytic Essays* (New Haven, CT: Yale University Press, 1993), 46–7. For a different distinction (event space vs. tonal space), see Patrick McCreless,"Syntagmatics and Paradigmatics: Some Implications for the Analysis of Chromaticism in Tonal Music," *Music Theory Spectrum*, 13/2 (Autumn 1991), 147-78.
[43] Ibid, 31.
[44] Ibid.
[45] Yet, beginning music students on many instruments conceptualize note order from low to high (a formal layout) before, or while simultaneously learning the figural layout of the score.

study by Jeanne Bamberger in which children are allowed to conceptualize the tune "Twinkle, twinkle, little star" in different ways—one formal, one figural, and one a hybrid between the two. For illustrative purposes, the purely formal and figural representations are reproduced below.[46]

Figure 2: "Twinkle, twinkle" Figural Layout (and Path) (quoted from Example 2.8a, Lewin, 1993)[47]

Figure 3: "Twinkle, twinkle" Formal Layout (and Path) (quoted from Example 2.8b, Lewin, 1993)[48]



After Lewin, other scholars have used formal geometric representations for analytical uses, including Daniel Harrison,[49] Berthold Hoeckner,[50] Edward Gollin,[51] and Richard Cohn.[52] My more figural graphic approach might be equated to that of an "enthusiastic music student at an early stage of his musical training," but this approach is purposeful. I attempt to represent the weight of temporality in music's function for the reason that I wish to represent the general normality of music's workings in a temperament. By utilizing a figural versus formal representation, I hope to create a direct mirror between a graphic temporal unit and a measure. Figural analyses have been used to show relationships among pitch, temporality, and tuning: Henry Klumpenhouwer has wonderfully attempted to trace René Descartes's intonation rules

[46] Ibid, 46.
[47] Lewin, 46.
[48] Lewin, 46.
[49] Daniel Harrison, "Nonconformist Notions of Nineteenth-Century Enharmonicism," *Music Analysis* 21, no. 2 (July 2002): 115–160.
[50] Hoeckner Berthold, "Paths through Dichterliebe," *19th-Century Music* 30, no. 1 (Summer 2006): 65–80.
[51] Edward Gollin, "Representations of Space and Conceptions of Distance in Transformational Music Theories" (PhD diss., Harvard University, 2000).
[52] Richard Lawrence Cohn, *Audacious Euphony: Chromaticism and the Triad's Second Nature*, (New York: Oxford University Press, 2012).

from *Compendium Musicae* through the short, highly chromatic piece "Carmina chromatico" from *Prophetiae Sibyllarum* by Orlando de Lassus.[53]

Project Confines

The boundaries and limits of this research and the system of graphing that developed out of it should be established upfront. Almost without fail, the consultation of each additional work altered the analytical model; one could probably assume that an analysis of more works would further develop and change the system. The scope of interest could probably be as wide as all music, both presumably and potentially written with meantone in mind. However, the confines and inspiration for this project distilled the examined pieces down to a group of eleven—all praeludia by Buxtehude. The examined pieces include the three Praeludia in C Major (BuxWV 136, 137, 138), the Praeludium in D Major (BuxWV 139), Praeludium in D Minor (BuxWV 140), Praeludium in E Major (BuxWV 141), Praeludium in E Minor (BuxWV 142), Praeludium in F Major (BuxWV 145), Praeludium in F-sharp Minor (BuxWV 146), Praeludium in G Major (BuxWV 147), and the Praeludium in G Minor (BuxWV 149). Some of the most harmonically adventurous organ works of the seventeenth century are probably the north German praeludia—more specifically, the praeludia of Buxtehude.[54] Hopefully this system can easily transfer itself to other genres.

For the purposes of empirical consistency, a few simple procedures were adhered to. Scholars more familiar with the pieces and genre in question might feel more comfortable

[53] Henry Klumpenhouwer, "The Cartesian Choir." *Music Theory Spectrum* 14, no. 1 (Spring 1992): 27.
[54] Compelling arguments could easily be made that equal or greater harmonic interest (or even influence) exits in the Italian *Durezze e ligature* style, Frescobaldi's toccatas in general, chromatic fantasies, or even the French *Plein Jeu* movements.

working outside of these few procedures. In the case of *musica ficta*, some may even feel comfortable making decisions based upon my graphs rather than the music.

(1) The Broude/Belotti edition is the only edition consulted.[55]
(2) *Musica ficta* are not included in the graph.
(3) Formal sections are noted only when included in the Broude/Belotti edition.[56]

The Graphing System

Setting Up a Graph

The x-axis is organized in tempered perfect fifths with G flat as the leftmost pitch and B sharp as the rightmost.[57] If a piece extends past these boundaries, columns can be added. The y-axis is time as it unfolds through a piece of music. The standard temporal unit is the measure, which is weighted no differently for meter changes, but it can be halved under specific circumstances.[58] When dealing with a graph that unfolds in time, it is necessary to have a unit. No unit could possibly yield universally comprehensive observations, but measures seem to contain enough information and are rarely oversaturated; apart from these preferences, this choice was made arbitrarily.

Further boundaries can be established with reference to meantone. Under no circumstances would the pitches G flat, D flat, E sharp, and B sharp be available in meantone so these entire columns are shaded for illustrative purposes. These areas are entered with some frequency, so it is important that the standard cell shading stands out against the boundary shading. Three more columns—A flat, D sharp, and A sharp—are shaded with slightly less

[55] Dieterich Buxtehude, *Dieterich Buxtehude: The Collected Works*, ed. Christoph Wolff and Michael Belotti, Vol. 15/A (New York: Broude Trust, 2001).
[56] This decision was made with some reservation since the formal sections almost definitely enlighten certain trends.
[57] This kind of representation can be seen regularly in music theoretical analysis. For an analysis of individual chords through the lens of stacked, or circled fifths, see Scott Murphy, "A Composite Approach to Ives' "Cage"," *Twentieth Century Music* 5/2 (September 2008), 188.
[58] This possible option can only be used in certain circumstances detailed in Appendix 3. If units are split too often, it quickly leads to an overemphasis of musical events that should be considered somewhat ordinary.

emphasis, since they could have been accounted for by split keys or some kind of modified meantone.

Functions of Shading

"To interpret music is to ignore information."[59] This graphic analysis leaves music notation behind, and therefore leaves out all sorts of contrapuntal, harmonic, and melodic specifics. By clearing the piece of this material, the hope would be to uncover something underneath it all. This graphic system utilizes a unit-by-unit analysis that uses an almost binary code: if a certain pitch is active in a temporal unit, or measure, then it is shaded; if it is not, it is left unshaded. This "yes-no" binary is expanded by utilizing other types of shading to capture different, somewhat regular events. These categories were developed in an attempt to regularize information in each measure, and to make logical sense of musical information. Basically, a row (one temporal unit) cannot exceed seven spaces (or six stacked fifths) since that would exceed a diatonic collection of pitches and also the boundaries of meantone. Since the temporal unit is arbitrary, they often contain more pitch material than is allowed. This extra pitch usually does not sound simultaneously with a pitch seven or more fifths away, so it is not considered problematic. Therefore, a pitch is then selected as hierarchically more important, and the remaining are shaded in some other manner.

Figure 6 contains detailed information on graphing subtleties and explanatory prose is located in Appendix 3, but for general understanding, it is only necessary to recognize the six different possible cell colorings. Their "type" coding assignment is also explained in Appendix 3, but is given here if it is necessary for understanding part three of this document.

(1) Dark Grey Shading
(2) Diagonal Shading

[59] Clifton Callender, Ian Quinn, and Dmitri Tymoczko, "Generalized Voice-Leading Spaces." *Science*, 320/5874 (April 2008), 346.

(3) Horizontal Hashing
(4) Dotted Shading
(5) Black Shading
(6) Light Grey Shading

Each shading functions differently, but some general explanations can be summarized. Dark Grey shading is the standard "yes-no" binary shading used for identifying central, structural pitch material. Diagonal shading is used for various types of measures containing more pitches than are allowed in a diatonic collection. Horizontal hashing is used for occurrences of chromatic passing tones, highlighting the occurrence of an augmented unison. Horizontal hashing is coded "type 3." Dotted shading is used to highlight absence of pitch for rhetorical gestures. Black shading, which is coded "type 5," denotes an occurrence of simultaneous pitch material that overextends the bounds of meantone tuning. Light grey shading is somewhat similar to an unshaded cell, but is used to visually regularize a row length regardless of absence of a particular pitch.[60] This is primarily a visual aid as it helps the eye with continuity that is sometimes shielded by an unchanging temporal unit.

Interpretation

Interpretation of each individual graph is located in Part III, but some general ideas are located here. This meta-analysis admittedly distances the reader one step further from the actual piece of music, but this step back enables one to look at unadorned trends in each piece, and perhaps some trends of an overall genre. First, it is necessary to acknowledge the difference between continuous rows and interrupted rows. The standard continuous rows account for major and natural minor while the interrupted rows account for ascending melodic or harmonic minor. Rather than thinking of minor rows as a littering of pitches, it is beneficial to think of them as

[60] Light grey shading is discussed in detail in Appendix 3, but Appendix 4 should be consulted for explanations of standard row lengths.

interrupted rows where one or more pitches is displaced. This easy perspective change enables one to make quick sense of seemingly complicated floating pitch material.[61]

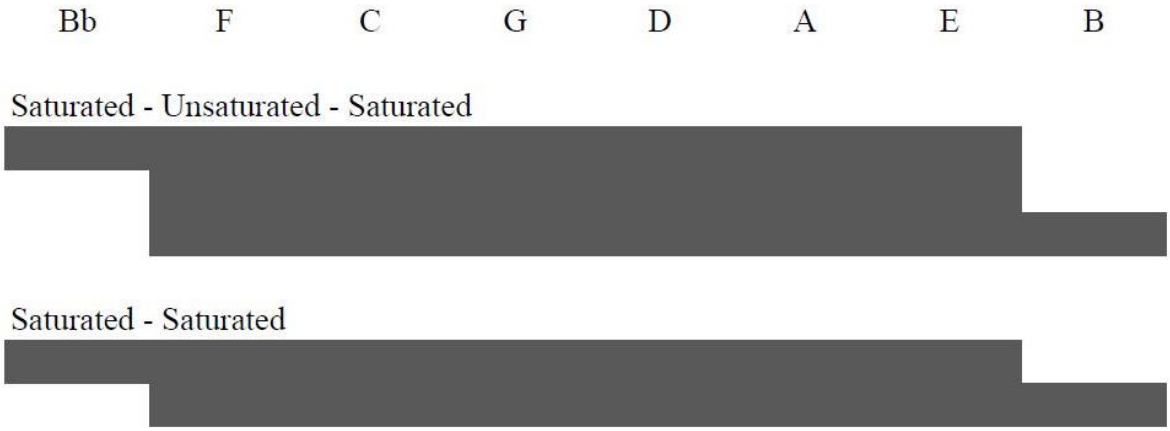
Figure 4: Minor Row Conceptualization

Instances of tuning problems appear in these graphs in two ways: (1) black shading, that indicates simultaneous pitch material that is not in tune in meantone; and (2) any type of shading that extends into the outer boundaries marked by the two different crosshatched shadings. This extension would also indicate the possibility of tuning problems in the inner boundaries and the inevitability of tuning problems in the outer boundaries. On first glance, it is also possible to identify harmonically charged sections that move quickly from side to side versus sections that are stagnant or only fluctuate between tonic and dominant. This relative motion may potentially be linked to larger, perhaps intentional, uses of a tuning system in the context of composition.

Considering how the graph moves through looking at row length might also say something about the harmonic motion and even tension within a piece. Saturated diatonic heptachords or rows of seven cells are probably most frequently traversed from one to another, but sometimes music passes from one diatonic collection to another a fifth away through their common hexachord acting as a buffer.

[61] For a more detailed discussion of row length and ascending melodic and harmonic minor, one should consult Appendix 4.

Figure 5: Row Movement, Buffer vs. No Buffer Comparison



If the temporal unit was refined, this buffer would be seen more regularly, but even with the present unit size these buffers can sometimes be observed. And, when they do occur at this focus level, buffers can help to identify slower harmonic motions. The distance that a row moves horizontally between each temporal unit is significant and shows restraint or lack thereof in the composer's choices.

Numerical Data

Using computer spreadsheets as the basis for a graphing system led naturally to the possibility of extracting numerical data by employing various formulas to illustrate tendencies in each piece. Due to the nature of creating formulas and data from a purely visual product, there is a degree of arbitrariness in assigning numbers. Nonetheless, consistency makes up for decisions and unifies data. Due to length of its explanation and an interest in maintaining the flow of the main text, the extended explanations have again been relocated to Appendix 5. Appendix 1 contains all the graphs, side-by-side with the measure-by-measure numerical data. Appendix 2 has been included to better display average data and to include some comparative analysis of the obtained data.

Acknowledgement of Problems

These graphs, functional as they may be, utilize what is still a prototype system. As discussed, things like arbitrary temporal units and numerical assignments could stand further refinement. Formal analysis, rhetorical or not, has had exceedingly little to do with the development of the graphing system.[62] The seventeenth-century problem of tonality versus modality is far from captured here. I have tried to be sensitive to this issue, but it mostly affects writing style, in which, for instance, I use the words major or minor without significant hesitation.[63] The graphing system's present form is the most up-to-date and thorough illustration I have so far been able to establish.

[62] Scholarship, beyond the scope of this project, should be consulted for insight into formal analysis. Leon W. Couch III, "Musical-Rhetorical Analysis and the North German Toccata" (PhD diss., University of Cincinnati, 2003); ____, "The Organ Works of Dietrich Buxtehude (1637–1707) and Musical-Rhetorical Analysis and Theory" (DMA diss., University of Cincinnati, 2002); and Lena Jacobson, "Musical Rhetoric in Buxtehude's Free Organ Works" *Organ Year Book* XIII (1982): 60–79. For an overview of rhetoric in music inclusive of the contemporary theories of Burmeister and Mattheson see Patrick McCreless, "Music and Rhetoric," in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), 847–79.

[63] For an overview seventeenth century harmonic theory see Gregory Barnett, "Tonal Organization in Seventeenth-Century Music Theory," in *The Cambridge History of Western Music Theory*, ed. Thomas Christensen (Cambridge: Cambridge University Press, 2002), 407–55. For some ideas pertaining specifically to the music of Buxtehude see William Porter, "Psalm-Tone Formulas in Buxtehude's Free Organ Works." In *Charles Brenton Fisk: Organ Builder*, ed. Fenner Douglass, Owen Jander, and Barbara Owen, (Westfield Center for Early Keyboard Studies, 1986.), 161–7 4; and Lizette Rocío Chapa Fuentes, "Pitch Organization and Texture in the Free Organ Preludes of Buxtehude" (Master's thesis, Boston University, 2011).

Part III – Analysis

In the following section, individual pieces are analyzed. Each analysis may contain references to other pieces. These references, though somewhat numerous, were allowed to flow organically rather than moving them to a separate place. Due to the nature of analyzing eleven pieces, each analysis has been kept relatively short. The analyses all reference the material in the appendices, particularly the graphing subtleties in Appendix 3. Though some fruitful observations may be made, the primary goal of this document has not been to draw conclusions, but rather to develop a system that, given time and nurturing, could help to draw conclusions. In order to develop any consistent system, many varying examples must be consulted.

Individual Analyses

Praeludium in C Major – BuxWV 136

This piece is ninety-six measures long and contains only one note outside of the meantone center. It includes seven separate instances of "type 5" measures, yet only one is at all significant, because it occurs at the very same moment as the only instance that the boundaries of the meantone center are ruptured (m. 53). It is interesting to note that out of the examined pieces, this relatively tame piece has the longest average row length, just above seven. This means that there are very few row lengths fewer than seven. It should not come as a surprise that there are no examples whatsoever of transitional buffering.

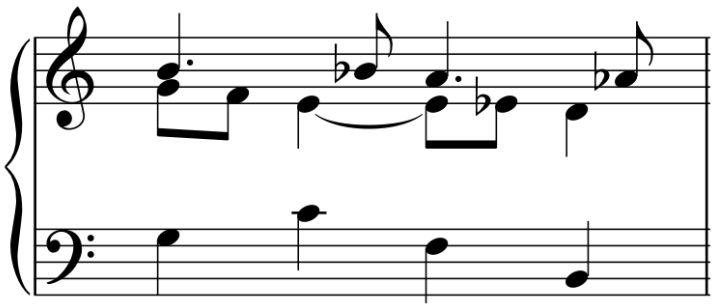
What might be even more strange is that the average row movement of this piece is comparatively somewhere in the middle. For a piece with no transitional buffering and only one departure from the meantone center, it is remarkable that its average row movement is ranked even moderately. A potential explanation for the high average row length and its moderate

average row movement might seem on the surface level to do with the fact that it is one of the few pieces that contains three fugues, because fugues often contain primarily saturated units that move easily back and forth between tonic and dominant without transitional buffers.[64] The problem with this hypothesis is that there are still a significant number of measures that do not contain any fugal material since the fugues are quite short. On the other hand, this hypothesis, paired with the fact that the non-fugal material is often active passage work, seems to hold quite soundly.

Praeludium in C Major – BuxWV 137

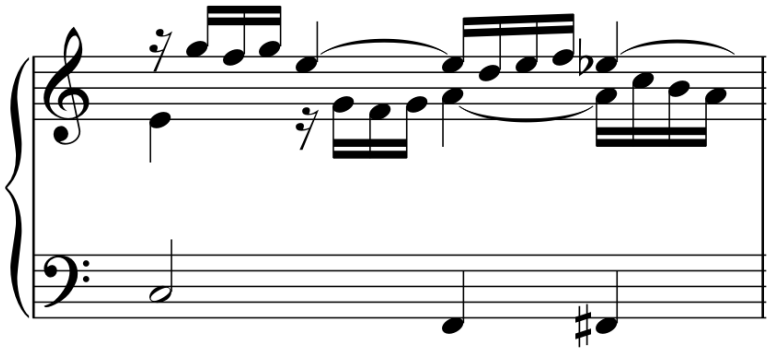
This 107-measure-long piece contains only two departures from the meantone center. Its measure (m. 20) containing three augmented unisons earns it the highest value row width among all of the analyzed praeludia (tied with BuxWV 142). This moment occurs right after the upward moving dotted rhythm section and acts as a sort of cascade stretching downward chromatically. This very same measure contains one of the piece's six "type 5" codings. This would be more significant if it were not for the more important "type 5" coding in measure 73. This is one of very few "type 5" codings in the examined pieces that is this significant and the shock value of this fully-diminished seventh chord built on a raised fourth scale degree cannot be overstated. Two measures later, Buxtehude writes the triumphant, iconic *Ciacona*.

Example 1: BuxWV 137, m. 20.



[64] The others are BuxWV 141, 142, and 150. Snyder, 241.

Example 2: BuxWV 137, m. 73.



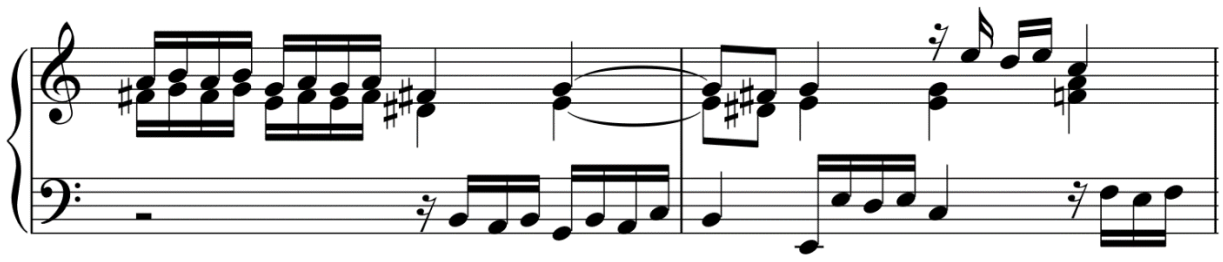
The instance of A flat in both BuxWV 136 and 137 are similar; both could be interpreted simply as an instance of writing for shock value; however, the D sharp occurrences in measures 29 and 30 of BuxWV 137 are something different. This moment occurs in no way at a pivotal or particularly dramatic point in the piece. The second of the two instances could be sidestepped without much issue, but the first instance is on a strong beat for the entirety of the beat. It seems reasonable to conclude that an organ with either split keys or some modified system was in mind during composition. Still, drawing a conclusion such as this based on a single instance seems a bit presumptuous. Snyder states,

> This praeludium offers an excellent example of a piece containing a few notes beyond the range of mean tone or the pedal compass that are either quite easily circumvented or that pass by nearly imperceptibly.[65]

Though I disagree that measure 73 passes by "nearly imperceptibly," or that measures 29 and 30 would not be wholly uncomfortable without subsemitones or a modified system, she does have a good point that this piece does seem to lie quite comfortably within the meantone center.

[65] Snyder, 246.

Example 3: BuxWV 137, mm. 29 and 30.

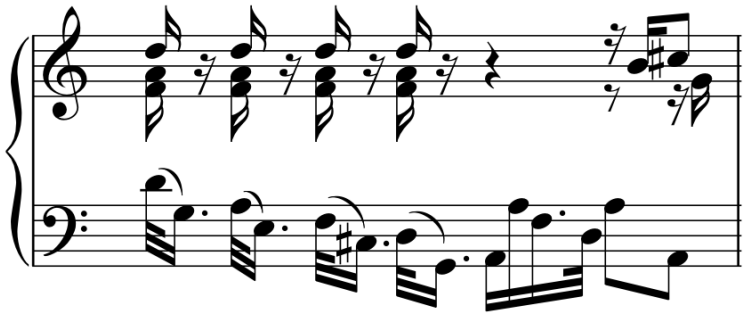


Just a glance at this graph reveals that there are particular instances where significant explorations are made, while the majority lies perfectly in the middle. It is not unreasonable to conclude that this form of exploration is related to the composer's awareness of the constraints and benefits of a particular tuning system. By remaining in the meantone center for the majority of the piece, excursions, except measures 29 and 30, are limited to places where Buxtehude probably intended to be dramatic, exercising his will as composer to traverse across that imaginary boundary.

Praeludium in C Major – BuxWV 138

This and the Praeludium in G Major (BuxWV 147) are the only two analyzed pieces that completely stay within the boundaries of the center of meantone temperament. The only "type 5" coding that occurs is in measure 8, a measure that was only coded "type 5" as a technicality. The miniscule overlap of C sharp and F is more insignificant than any other "type 5" coding that has so far been analyzed.

Example 4: BuxWV 138, m. 8.



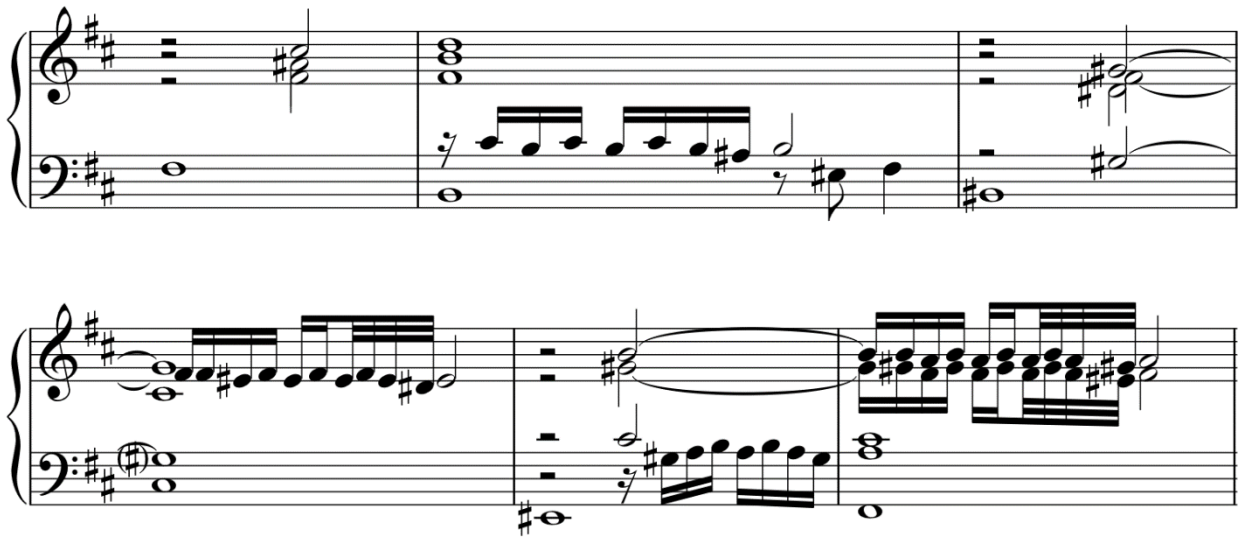
Like BuxWV 136, this piece is ranked toward the top for having a high average row length, but unlike BuxWV 136, it is ranked lowest for average row movement. Though the difference is not that large, it does further support the behavior of this piece. It is possible that this is correlated with its inability to breach the meantone boundaries, but such conclusions can not be drawn at this point since enough data has not been compiled.

Praeludium in D Major – BuxWV 139

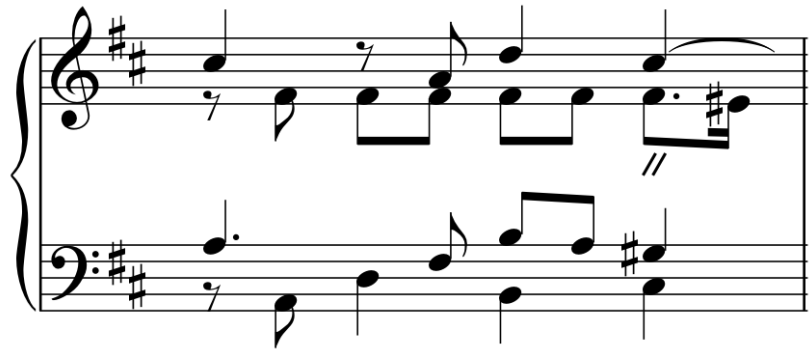
The graph of the Praeludium in D Major is probably the strangest looking graph with its jagged outcropping to the right just before the end of the piece. The score itself is almost as striking. Though the section from measures 87 through 92 is definitely beyond noteworthy, it is the fugal entries in measures 47 and 49—F-sharp minor, and C-sharp minor, respectively—that are particularly baffling. Fugue subjects rarely enter in such distant keys before the eighteenth century, and even less frequently in the confines of a restrictive temperament. As has come to be expected, the greatest discrepancies in tuning with regard to the music and meantone temperament occur in a free section. Perhaps these extreme occurrences could be covered with some creative registration or a tremolo as Davidsson demonstrates. Snyder echoes the suggestion that this free section can be played and registered in a manner that makes it acceptable.[66] The subject entries in measures 47 and 49 seem to defy the temperament, but if treated gingerly by the performer, it is possible that these pitches go by almost imperceptibly without offending the listener.

[66] Snyder, 244.

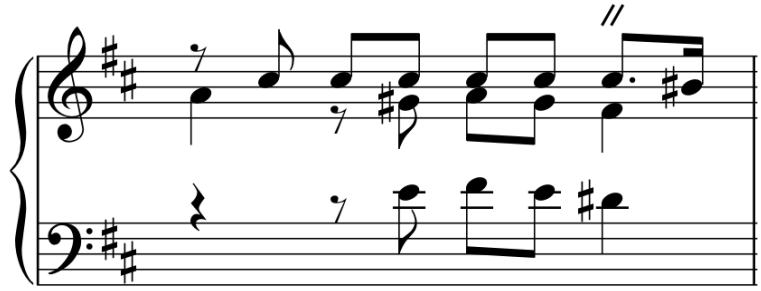
Example 5: BuxWV 139, mm. 87 to 92.



Example 6: BuxWV 139, m. 47.



Example 7: BuxWV 139, m. 49.



Aside from these extreme moments, D sharps and A sharps occur somewhat regularly, so it is probably acceptable to assume that these pitches should be accounted for in some way—whether as a subsemitone or some tuning adjustment. The most notable oddity in the numerical

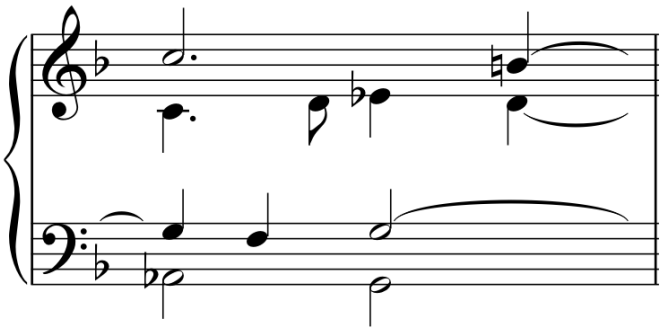
data comes from the relatively low average row movement. The piece's occasional distant excursions seem to be counterweighed by sections of relative motionlessness (see sections like mm. 50 to 61).

Praeludium in D Minor – BuxWV 140

> The D Minor Praeludium is a weighty work with a five-part overall form, alternating three free sections with two fugues. The bold subject of its first fugue (mm. 20 to 44) is quintessentially Buxtehudian, combining three elements often found separately in his fugue subjects: octave leaps, rests, and repeated notes. The fugue is worked out in triple counterpoint with two simultaneous countersubjects that bridge the rests, providing continuity rather than the concertato effect found in the fugue of the D Major Praeludium.[67]

Snyder goes on to further praise the construction of the piece. This complicated, tight construction leads to only ten instances of "type 5" coding and three A flats which account for the only departures from the realm of standard meantone temperament. Several of the "type 5" measures are quite dramatic, most notably measure 43, but all are formally contained in free sections (excepting m. 40). The three A flats are a bit harder to deal with. Two of them occur in quick succession, but the other is separated by nearly ten measures and definitely belongs to a separate free section. Only one of the occurrences holds any weight, and it is in the pedal (m. 61). It is notable that the pattern of only extending the temperament during free, dramatic sections is faithfully maintained in this piece.

Example 8: BuxWV 140, m. 61.



[67] Snyder, 244–5.

Praeludium in E Major– BuxWV 141

This piece stands as one of the famous departures from meantone tuning. Containing E sharp, B sharp, and even F double sharp, it also contains regular D sharps and A sharps. It is not possible to play this piece in meantone without some kind of modification or subsemitones. When dealing with regular occurrences of external pitches, problems occur in analysis since written pitches are no longer sounding pitches. The Praeludium in E Major defies the kind of explanation that can be provided for the majority of the other pieces, so in lieu of this kind of analysis, several numerical observations are made. First of all, just over 90% of this piece's temporal units activate one or more pitch that is in the split key or modified meantone area. This is over 30% higher than even the Praeludium in F-sharp Minor (BuxWV 146). Yet, it contains around 15% of outright external pitch material while BuxWV 146 contains just over 51%. That is a clear and significant difference. While that 15% is still over double the percentage of the next lowest piece, Praeludium in D Major (BuxWV 139), it seems like meantone cannot be totally ruled out. In many ways, the offending moments in BuxWV 141 are less pungent than those of BuxWV 139.

The transposition hypothesis certainly seems possible here, but Davidsson's recordings in both E major and C major demonstrates, at least to me, that transposition is not necessary. His second recording of the piece, transposed to C, is certainly stylish and does open up a fair amount more registration possibilities since he can use all the manuals (only one of the keyboards he uses has an A sharp subsemitone), but it loses its unique flair and edginess that defines it. The piece's five "type 5" measures would be carried through any transposition. The graphing system developed here could easily be used to demonstrate transposition, and new data could be calculated.

Praeludium in E Minor – BuxWV 142

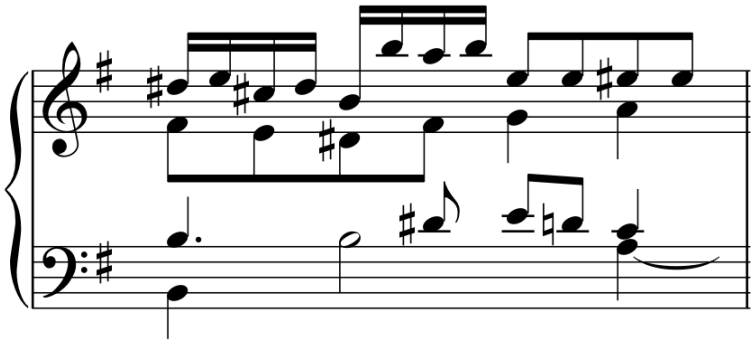
One of the hypotheses that seemed sensible when this project began was whether or not numerical data, or a graph for that matter, could demonstrate certain tendencies of composers and their compositions in certain keys.[68] Without laying that hypothesis completely to rest, this document has shown no such tendencies in the three pieces in C major. No such trend will be shown here either. Though Buxtehude's other free works in E minor are beyond the scope of this project, it is possible to tell just from glancing at them that they do not share the same pervasive affinity for augmented unisons. The regular "type 3" coding found throughout this piece has skewed the data tremendously. It ranks highly in average row width, highest value row width, average row width change, and average row movement—this is an active piece.

Davidsson humors the transposition hypothesis by recording this piece in both E minor and in D minor, again, with the same results: it greatly opens up registration possibilities, but some of the piece's character is lost. When a unit like the second half of measure 31 sounds perfectly fine (as the E sharp sounds as an F), one has to wonder why a piece with just a few other infractions (only 3.47% of temporal units) would need to be transposed on an organ with subsemitones or a modified temperament.[69]

[68] Theoretically correct meantone (not modified) does not affect the character of each key like it would in a circulating temperament, but as distant keys are approached, major tuning issues arise. This problem may affect a piece's journey through time and its potential avoidance or embrace of other key areas (more or less in the center of meantone temperament).

[69] Snyder is right to point out this piece's large relative weight given to fugues over free sections (see Snyder, 243). It is worth noting this since this piece has relatively few standout exploratory moments. If it did, the percentage of offending temporal units that extended the bounds of meantone (beyond subsemitones or modified temperament) would be greatly increased because this particular key already stands right on the border. This seems like it could be potential evidence of intentional composition that explores the boundaries of meantone (by composition in a particular key), but does not break them (though including many "type 3" measures). Simply put, is including little emphasis on the free sections an excuse not to explore due to the restraints of a temperament?

Example 9: BuxWV 142, m. 31.



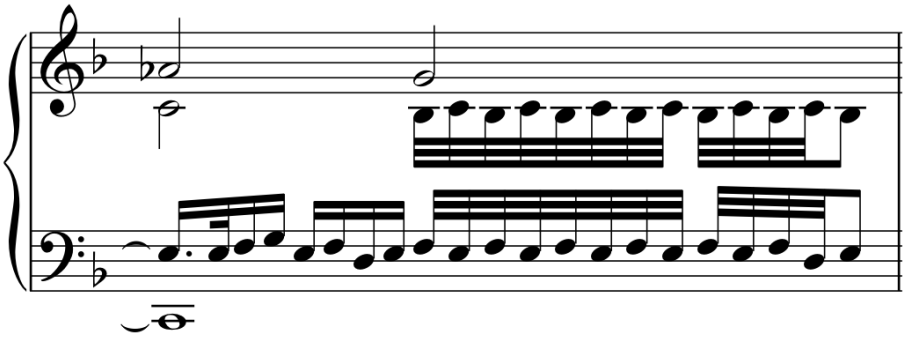
That aside, nearly 66% of the piece's temporal units contain pitches that require subsemitones or modified temperament. This piece, unlike BuxWV 141, carries significantly more "type 5" problems with it through transposition. When a composer intentionally includes intervals that are out of tune, regardless of transposition, then one is left with no middle ground: either, the piece was intended to occasionally be dissonant—as Vogel would have it, for shock value—or the piece was not intended for meantone.[70]

Praeludium in F Major – BuxWV 145

The Praeludium in F Major (BuxWV 145) is almost entirely in the bounds of meantone without split keys or modifications, and is definitely comfortable if subsemitones exist or modifications to the G sharp are made. Only five units contain the pitch A flat. As was the case in BuxWV 137, the most prominent instance of a departure from the meantone center is paired with a "type 5" coding in measure 125.

[70] It is hard to resist expressing a preference for the former since the piece feels so alive in Davidsson's "as-is" recording.

Example 10: BuxWV 145, m. 125.



The piece shares many of its characteristics with BuxWV 137, but since its tonal center is one pitch farther to the flat side, it naturally contains slightly more instances of A flat (five vs. one) and no instances of D sharp.[71] It is notable that both BuxWV 145 and 137 place a similar level of unimportance between the D sharp instances in BuxWV 137 and all of the A flat instances in BuxWV 145 except measure 125.

Praeludium in F-sharp Minor – BuxWV 146

> It is unplayable in this key on a mean-tone organ—even with subsemitones—but it works quite well, even if it loses some of its edge, when transposed to G minor, as Harald Vogel has demonstrated in his recording on the Langwarden organ, tuned in modified mean tone.[72]

Snyder's comments are almost without fail helpful, insightful, and frequently enlightening. One of the goals of the graphing system has been to help to better define the term scholars use regularly, "unplayable." What *exactly* makes a piece unplayable? Though a definite line between playability and un-playability may be no closer than before, better observations can be made on either side of that imaginary line. BuxWV 146, without a doubt, contains the highest percentage of units containing pitch material not available even with subsemitones or a modified system. This whopping 51% is nearly 30% more than the Praeludium in E Major and about 45% more than the next highest

[71] As would be expected in any temperament.
[72] Snyder, 258.

piece (Praeludium in D Major). It definitely should not go unnoticed that only about 58% of the units venture into the lesser area (split keys or modified temperament) while the Praeludium in E Major is just over 90%. It is again worth noting that the piece's twenty-five "type 5" measures would be moved through a potential transposition. It is hard to imagine another way that this piece could be performed on a meantone organ other than through transposition. It remains to be seen if there would be any particular benefit of playing it in some other temperament.

Praeludium in G Major – BuxWV 147

This piece, like the Praeludium in C Major (BuxWV 138), contains no pitch material outside of the meantone center. Furthermore, this is the only examined piece that contains no instances of "type 5" coding. In fact, the only moment that even toys with one of meantone's conspicuously impure intervals is debatable: measure 8 contains the only "type 3" moment with the augmented unison from C to C sharp.[73] If there is a scientific control out of this selection of pieces that works perfectly in meantone, it would be this piece.

Praeludium in G Minor – BuxWV 149

Around 15% of temporal units utilize at least one pitch requiring split keys or modified temperament, while only 0.62% require pitches that are completely foreign to meantone. These numbers, though not negligible, seem to suggest that the piece requires split keys or modified meantone while the 0.62% of units probably occur at the last few measures of a free section. The first part is certainly true, but the only unit containing completely foreign pitches is measure 126,

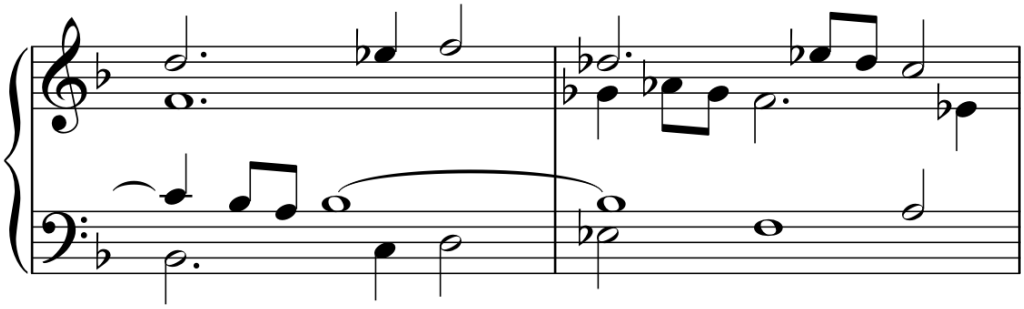
[73] For a discussion of the strains of tuning on augmented unisons Appendix 3, "type 3."

located in the latter half of the second fugue. It seemingly comes from nowhere and the row moves an abnormally high amount from the previous row. Snyder describes this measure,

> Beginning with an unprepared flatted seventh, is one of the most expressive moments in any of his fugues. This chord heard as E flat, B flat, F sharp', C sharp'', has a startling but by no means unpleasant effect in mean tone.[74]

This admittance by Snyder is both relieving and disheartening at the same time. On one hand, she accepts a dissonant dramatic moment as acceptable, but on the other, brushes off simultaneous distant pitches that I have coded "type 5." I certainly agree that this chord is not unacceptable, but it also marks an outright tension with meantone, albeit temporary. This piece also accounts for the highest average row movement, making it very harmonically active.

Example 11: BuxWV 149, mm. 125 and 126.



Conclusions are Only Starting Points

It can be unsettling that some scholars seem to consider occurrences of certain external pitch material—whether completely foreign or not—as irreconcilable in meantone. Snyder is not the only one to use the term "unplayable." Jooyean Cha states,

> Three of his [Buxtehude's] grandest pieces, the Praeludium in E Minor (BuxWV 142), D-Major (BuxWV 139), and F-sharp Minor (BuxWV 146) are unplayable[75] in meantone.[76]

[74] Snyder, 247.

The very same scholars do not even acknowledge simultaneous pitch material that overextends the bounds of meantone, accounted for here by "type 5" coding. If the only evidence was Davidsson's recording, the case of "unplayable" pieces could be closed; however, the scholarly itch is too great to not ask why. Offenses against meantone of both kinds are givens in every single one of the pieces examined except the Praeludium in G Major (BuxWV 147), and even BuxWV 147 includes a "type 3" coding. That being said, if anything is to be gained from further study in music and meantone, then one must search deeper. Perhaps eventually some theoretical basis can be formulated around the concerns of temperament's effects on composition and vice-versa. Below are a few ideas for making this graphic system more useful.

The potentialities of this graphic system could be used, for instance, to begin to predict percentages of columns in particular keys, relating those percentages back to a relative tonic, supertonic, median, etc. system whereas keys can then be compared. Perhaps, for example, the leading tone of the secondary dominant of most keys is used "x" percentage of the time while in A major, the D sharp is activated a lesser percentage; or, even more likely, the E sharp is activated less when in E major. It is already possible to consider a piece's trends by comparing R-L Row Placement to a control. The average R-L Row Placement for the three C Major Praeludia is 0.24 with a negative equivalent of -.76. Using this as a control, albeit a relatively weak one, it is possible to compare other piece's tendencies by subtracting the piece's key center number from the piece's actual R-L Row Placement number. The F major (BuxWV 145), for instance pushes a bit harder against the boundaries than one would expect at -.96. The E major

[75] It is odd that she exiles these pieces from performance in meantone, but also that she uniquely chooses these three while Snyder chooses others. Moreover, her comprehensive catalogue of Buxtehude in recorded sound includes Davidsson's effective performance of BuxWV 139 in meantone.
[76] Jooyean Cha, "Buxtehude's Organ Music as Captured in Sound Recordings," (DMA diss., Arizona State University, 2007), 12.

(BuxWV 141) pushes at around 0.3, just slightly more than the control. This data suggests that meantone tuning did not influence the choice and frequency of accidental usage and distant key excursions. To be more useful, this analysis needs to be combined with other kinds of data. While these numbers seem to deny the hypothesis that meantone affects Buxtehude's composition process, it fails to consider how these excursions occur.[77] This failure to capture "the how" of each boundary excursion is evident in this particular data, but also in the graphing system as a whole. Analyzing the R-L Row Placement averages fails to explain why, or at least presumably why, all the pieces with an average around or below .3 cannot be transposed to distant keys. In other words, why the C Major, F Major, etc. cannot, presumably, be played in E Major, while the E Major can be. In order to see this kind of trend, considerably more pieces would need to be graphed.[78] It seems reasonable to hypothesize that some trends could be established if they were pursued in the future.

It would be helpful to generate another set of numbers that considered both excursions from the meantone center as well as "type 5" coding. This would account for all offenses against the temperament and could be another way of predicting whether or not a piece was likely composed with meantone in mind. Furthermore, it would be beneficial to weigh and classify all exterior pitch occurrences. Doing so would make it possible to analyze and explain, again presumably, why the E Major (BuxWV 541) can be played in E major, but other pieces cannot.

A more thorough comparative analysis would involve simultaneously looking at a wider breadth of keyboard music including, particularly, music that was definitely composed with

[77] Though the coding system is inherently limited, the R-L Row Averages is attached to Unweighted Positive/Negative System, which is, by its nature, unweighted (See Appendix 5). This means that insignificant or less hierarchically important moments are given equal weight.
[78] Considerably, in this case, probably means well over 100.

meantone in mind by composers who state this themselves. Pending further investigation, this would probably include people like Arnolt Schlick.

Another idea would involve graphing and comparing keyboard music with other music, preferably without continuo, of the same composer. This may or may not yield various detectable trends in pitch activation and avoidance. Much care should be taken in considering the performance practices of the music in question. Obviously, when dealing with instruments other than large organs, even fixed pitch instruments can easily by re-tempered.

Finally, it might be fruitful to distinguish different kinds or levels of protrusions outside of the meantone center. Scholars agree that certain extensions are less problematic than others. Perhaps the less problematic ones could be accounted for visually and numerically in a different manner. This would weigh certain instances more or less than others, consequently helping the data work in more effective ways.

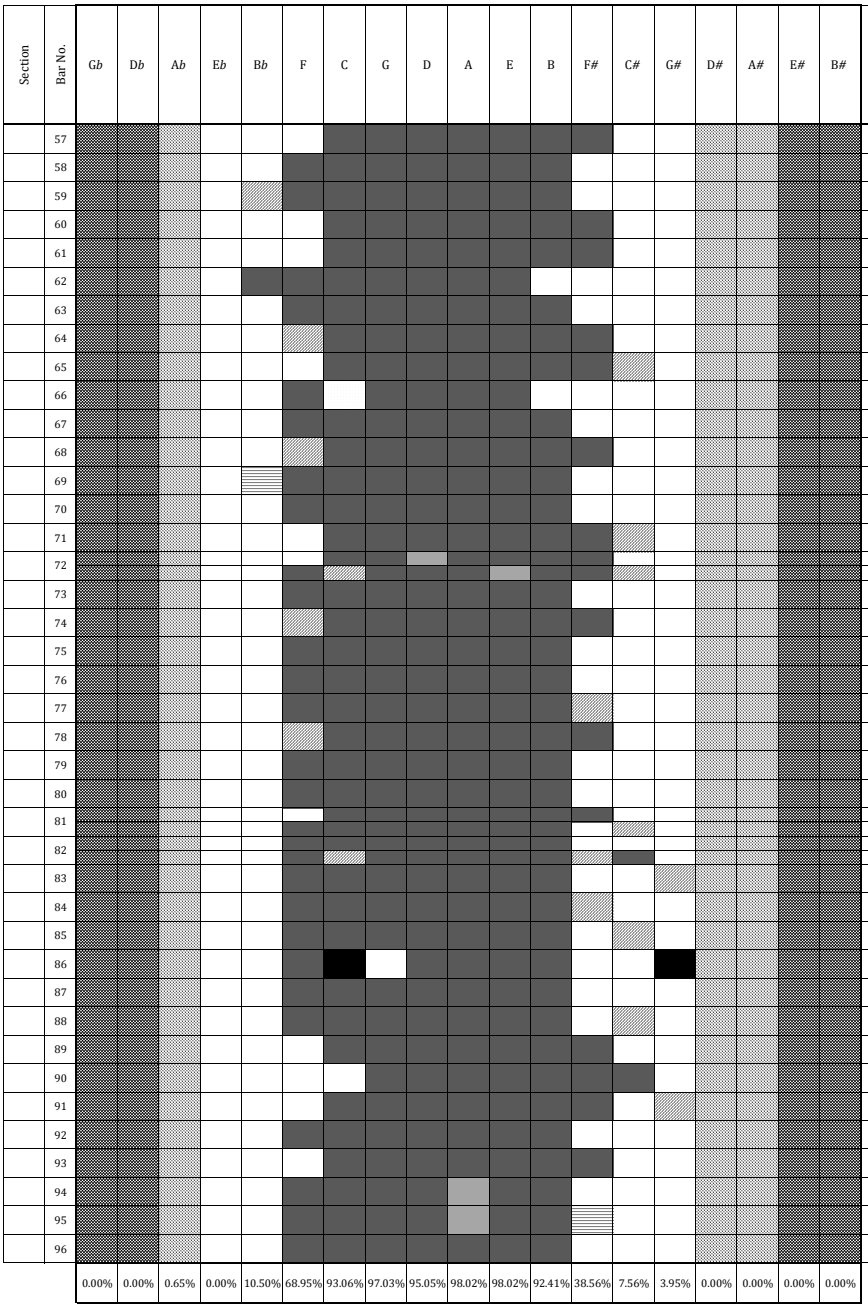
In the end, if none of this data is helpful or enlightening, at least the graphs have proven to be a visual force. Their imposing, time-dependent, figural nature enables the reader to very quickly gain an understanding of a piece's structure, several trends, and its tonal boundaries. Both the visual representations and the numerical data have their limits; even if all the proposed ideas eventually came to fruition, they would still have their limits. This, however, is the case with any analytical system and has been the plight of theorists for centuries.

Appendix 1: The Graphs

Praeludium in C Major (BuxWV 136)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (A♭, D#, A#)	Active External Pitches (G♭, D♭, E#, B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1																					0	0	0	7	0	0.00	0.00
	2																					0	0	0	7	0	0.00	0.00
	3																					0	0	0	7.33	0.33	-0.50	0.50
	4																					0	0	0	7	-0.33	0.00	0.50
	5																				3a	0	0	0	7.66	0.66	0.50	0.50
	6																				5b-1/1c-2	0	0	0	7.33	-0.33	0.63	0.13
	7																				5b-1	0	0	0	7	-0.33	2.00	1.38
																					6b-2/2a/1a-1	0	0	0	6.33	-0.67	0.86	1.14
	8																				5b-1/1c-2	0	0	0	7.33	1	1.38	0.52
	9																				5c-1/1a-1	0	0	0	7.33	0	0.75	0.63
	10																					0	0	0	7	-0.33	0.00	0.75
	11																					0	0	0	7	0	0.00	0.00
	12																				1a-1	0	0	0	7.33	0.33	0.50	0.50
Fuga	13																				4	0	0	0	4	-3.33	0.00	0.50
	14																				3a	0	0	0	7.66	3.66	-0.50	0.50
	15																					0	0	0	7	-0.66	0.00	0.50
	16																					0	0	0	7	0	0.00	0.00
	17																				3a	0	0	0	7.66	0.66	0.50	0.50
	18																				3c	0	0	0	7.33	-0.33	0.50	0.00
	19																				1a-1	0	0	0	7.33	0	0.50	0.00
	20																				3a	0	0	0	7.66	0.33	-0.50	1.00
	21																				3c	0	0	0	7.33	-0.33	-0.50	0.00
	22																					0	0	0	7	-0.33	0.00	0.50
	23																					0	0	0	7	0	1.00	1.00
	24																					0	0	0	7	0	0.00	1.00
	25																				3a	0	0	0	7.66	0.66	0.50	0.50
	26																				6a/3a	0	0	0	5.66	-2	-0.17	0.67
	27																				1a-1	0	0	0	7.33	1.67	-0.50	0.33
	28																					0	0	0	7	-0.33	1.00	1.50
	29																				1a-1	0	0	0	7.33	0.33	0.50	0.50
	30																					0	0	0	7	-0.33	1.00	0.50
	31																				1a-1	0	0	0	7.33	0.33	-0.50	1.50
	32																				1a-1	0	0	0	7.33	0	0.50	1.00
	33																				3a	0	0	0	7.66	0.33	0.50	0.00
	34																				1c-2	0	0	0	7.33	-0.33	1.50	1.00
	35																					0	0	0	7	-0.33	1.00	0.50
																					2a	0	0	0	7	0	1.00	0.00
	36																					0	0	0	7	0	0.00	1.00
	37																				3b	0	0	0	7.66	0.66	0.50	0.50
	38																				5b-1	0	0	0	7	-0.66	1.00	0.50
	39																				3b	0	0	0	7.66	0.66	0.50	0.50
	40																					0	0	0	7	-0.66	1.00	0.50
	41																				1a-1	0	0	0	7.33	0.33	0.50	0.50
	42																				6b-1/3a	0	0	0	6.66	-0.67	-0.14	0.64
	43																				1a-1	0	0	0	7.33	0.67	-0.50	0.36
	44																				3a	0	0	0	7.66	0.33	0.38	0.88
	45																					0	0	0	7	-0.66	0.00	0.38
	46																					0	0	0	7	0	1.00	1.00
	47																				1b	0	0	0	7.33	0.33	1.50	0.50
	48																				1a-1	0	0	0	7.33	0	0.50	1.00
	49																					0	0	0	7	-0.33	0.00	0.50
	50																					0	0	0	7	0	0.00	0.00
	51																				6a	0	0	0	5	-2	-0.60	0.60
	52																				6a	0	0	0	6	1	-0.33	0.27
	53																				6a/5b-1/3a	1	0	1	6.66	0.66	-1.86	1.52
	54																					0	0	0	7	0.34	-1.00	0.86
Allegro	55																					0	0	0	6	-1	0.50	1.50
	56																					0	0	0	7	1	0.00	0.50

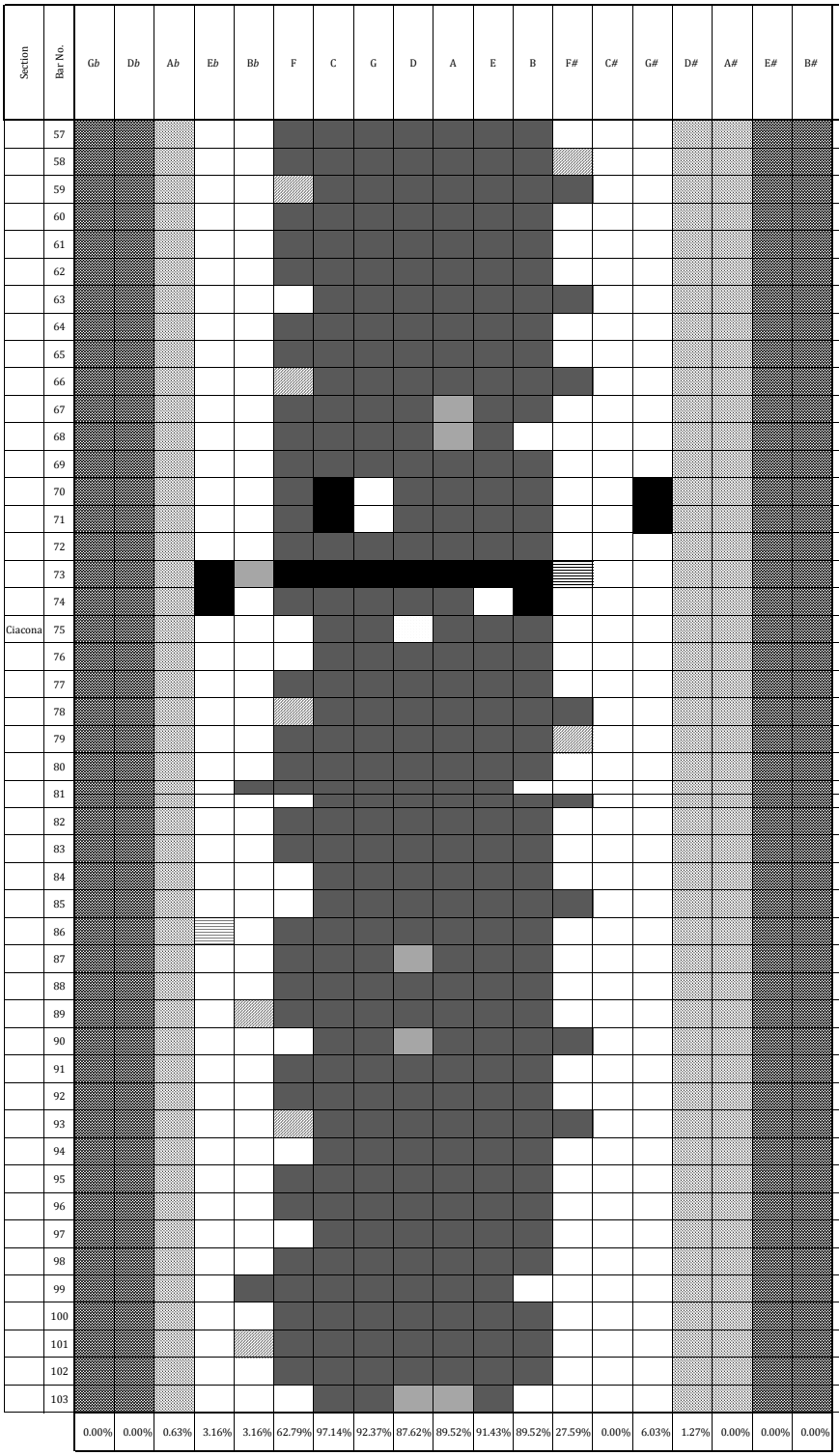
Praeludium in C Major (BuxWV 136)



Section	Bar No.	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	57		0	0	0	7	0	1.00	1.00
	58		0	0	0	7	0	0.00	1.00
	59	3c	0	0	0	7.33	0.33	-0.50	0.50
	60		0	0	0	7	-0.33	1.00	1.50
	61		0	0	0	7	0	1.00	0.00
	62		0	0	0	7	0	-1.00	2.00
	63		0	0	0	7	0	0.00	1.00
	64	1a-1	0	0	0	7.33	0.33	0.50	0.50
	65	1b	0	0	0	7.33	0	1.50	1.00
	66	4	0	0	0	5	-2.33	-0.20	1.70
	67		0	0	0	7	2	0.00	0.20
	68	1a-1	0	0	0	7.33	0.33	0.50	0.50
	69	3a	0	0	0	7.66	0.33	-0.50	1.00
	70		0	0	0	7	-0.66	0.00	0.50
	71	1a-1	0	0	0	7.33	0.33	1.50	1.50
	72	6a	0	0	0	6	-1.33	1.17	0.33
		6a/2a/1d	0	0	0	6.66	0.66	0.88	0.29
	73		0	0	0	7	0.34	0.00	0.88
	74	1a-1	0	0	0	7.33	0.33	0.50	0.50
	75		0	0	0	7	-0.33	0.00	0.50
	76		0	0	0	7	0	0.00	0.00
	77	1a-1	0	0	0	7.33	0.33	0.50	0.50
	78	1a-1	0	0	0	7.33	0	0.50	0.00
	79		0	0	0	7	-0.33	0.00	0.50
	80		0	0	0	7	0	0.00	0.00
	81		0	0	0	7	0	1.00	1.00
		2a/1a-2	0	0	0	7.33	0.33	0.63	0.38
	82		0	0	0	7	-0.33	0.00	0.63
		2a/1d	0	0	0	7.66	0.66	1.00	1.00
	83	1a-2	0	0	0	7.33	-0.33	0.75	0.25
	84	1a-1	0	0	0	7.33	0	0.50	0.25
	85	1c-2	0	0	0	7.33	0	0.63	0.13
	86	5b-1	0	0	0	7	-0.33	1.00	0.38
	87		0	0	0	7	0	0.00	1.00
	88	1a-2	0	0	0	7.33	0.33	0.63	0.63
	89		0	0	0	7	-0.33	1.00	0.38
	90		0	0	0	7	0	2.00	1.00
	91	1a-2	0	0	0	7.33	0.33	1.63	0.38
	92		0	0	0	7	-0.33	0.00	1.63
	93		0	0	0	7	0	1.00	1.00
	94	6a	0	0	0	6	-1	-0.17	1.17
	95	6a/3a/1b	0	0	0	6.66	0.66	0.43	0.60
	96		0	0	0	7	0.34	0.00	0.43

Gb	Db	Ab	Eb	Bb	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#
0.00%	0.00%	0.65%	0.00%	10.50%	68.95%	93.06%	97.03%	95.05%	98.02%	98.02%	92.41%	38.56%	7.56%	3.95%	0.00%	0.00%	0.00%	0.00%

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (A♭, D#, A#)	Active External Pitches (G♭, D♭, E#, B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1																				4	0	0	0	3	0	-0.33	0.00
	2																				6a/6b-1	0	0	0	4	1	0.25	0.58
	3																				6a/6b-1	0	0	0	6	2	0.83	0.58
	4																				6a/6d	0	0	0	4.33	-1.67	2.20	1.37
	5																				1a-1	0	0	0	7.33	3	0.50	1.70
	6																					0	0	0	7	-0.33	0.00	0.50
	7																				1a-1	0	0	0	7.33	0.33	0.50	0.50
	8																					0	0	0	7	-0.33	0.00	0.50
	9																					0	0	0	6	-1	-0.50	0.50
	10																					0	0	0	7	1	0.00	0.50
	11																				6a	0	0	0	3	-4	-0.33	0.33
	12																					0	0	0	6	3	0.50	0.83
	13																				6a	0	0	0	6	0	0.17	0.33
	14																				6a/1a-1	0	0	0	6.33	0.33	0.57	0.40
	15																				6a	0	0	0	6	-0.33	0.83	0.26
	16																					0	0	0	6	0	0.50	0.33
	17																				6a	0	0	0	6	0	0.17	0.33
	18																				6a	0	0	0	6	0	-0.17	0.33
	19																				6a	0	0	0	6	0	0.83	1.00
	20																				5c-1/3a	1	0	1	8.98	2.98	-1.50	2.33
	21																					0	0	0	7	-1.98	0.00	1.50
	22																					0	0	0	5	-2	0.40	0.40
	23																					0	0	0	7	2	0.00	0.40
	24																				6a/5b-1/1a-2	0	0	0	5.33	-1.67	1.33	1.33
	25																					0	0	0	7	1.67	0.00	1.33
	26																				1a-2	0	0	0	7.33	0.33	0.75	0.75
	27																					0	0	0	7	-0.33	1.00	0.25
	28																				1a-2	0	0	0	7.33	0.33	0.75	0.25
	29																					1	0	1	7	-0.33	2.00	1.25
	30																				6a/6b-2/1a-2	1	0	1	4.33	-2.67	2.40	0.40
																					2a	0	0	0	6	-1	-0.50	2.50
	31																				1a-2	0	0	0	7.33	1.33	0.50	1.00
	32																					0	0	0	6	-1.33	-0.50	1.00
	33																				6a	0	0	0	6	0	-0.17	0.33
	34																					0	0	0	6	0	-0.50	0.33
	35																				1a-1	0	0	0	7.33	1.33	0.50	1.00
Fugue	36																				4	0	0	0	5	-2.33	0.20	0.30
	37																				6a/6b-1/1c-1	0	0	0	4.33	-0.67	0.80	0.60
	38																				6a	0	0	0	5	0.67	0.00	0.80
	39																					0	0	0	7	2	1.00	1.00
	40																				1c-1	0	0	0	7.33	0.33	0.50	0.50
	41																					0	0	0	7	-0.33	0.00	0.50
	42																					0	0	0	6	-1	0.50	0.50
	43																				1c-1	0	0	0	7.33	1.33	0.50	0.00
	44																					0	0	0	7	-0.33	1.00	0.50
	45																					0	0	0	7	0	0.00	1.00
	46																				1c-1	0	0	0	7.33	0.33	0.50	0.50
	47																					0	0	0	7	-0.33	1.00	0.50
	48																					0	0	0	7	0	0.00	1.00
	49																					0	0	0	6	-1	0.50	0.50
	50																				6a	0	0	0	5	-1	1.00	0.50
	51																					0	0	0	7	2	0.00	1.00
	52																					0	0	0	7	0	1.00	1.00
	53																				6a	0	0	0	6	-1	1.17	0.17
	54																				1a-1	0	0	0	7.33	1.33	0.50	0.67
	55																				1a-1	0	0	0	7.33	0	0.50	0.00
	56																				6a/1a-1	0	0	0	6.33	-1	0.29	0.21



Section	Bar No.	Gb	Db	Ab	Eb	Bb	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	57																					0	0	0	7	0.67	0.00	0.29
	58																				1a-1	0	0	0	7.33	0.33	0.50	0.50
	59																				1c-1	0	0	0	7.33	0	0.50	0.00
	60																					0	0	0	7	-0.33	0.00	0.50
	61																					0	0	0	7	0	0.00	0.00
	62																					0	0	0	7	0	0.00	0.00
	63																					0	0	0	7	0	1.00	1.00
	64																					0	0	0	7	0	0.00	1.00
	65																					0	0	0	7	0	0.00	0.00
	66																				1a-1	0	0	0	7	0	0.50	0.50
	67																				6a	0	0	0	6	-1	-0.17	0.67
	68																				6a	0	0	0	5	-1	-0.80	0.63
	69																					0	0	0	7	2	0.00	0.80
	70																				5b-1	0	0	0	7	0	1.00	1.00
	71																				5b-1	0	0	0	7	0	1.00	0.00
	72																					0	0	0	7	0	0.00	1.00
	73																				5c-2/3a/3c	0	0	0	8.66	1.66	-0.11	0.11
	74																				5b-1	0	0	0	7	-1.66	-1.00	0.89
Ciacona	75																					0	0	0	5	-2	0.60	1.60
	76																					0	0	0	6	1	0.50	0.10
	77																					0	0	0	7	1	0.00	0.50
	78																				1a-1	0	0	0	7.33	0.33	0.50	0.50
	79																				1a-1	0	0	0	7.33	0	0.50	0.00
	80																					0	0	0	7	-0.33	0.00	0.50
	81																					0	0	0	7	0	-1.00	1.00
																					2b	0	0	0	7	0	1.00	2.00
	82																					0	0	0	7	0	0.00	1.00
	83																					0	0	0	7	0	0.00	0.00
	84																					0	0	0	6	-1	0.50	0.50
	85																					0	0	0	7	1	1.00	0.50
	86																				3a	0	0	0	7.66	0.66	-0.63	1.63
	87																					0	0	0	6	-1.66	0.00	0.63
	88																					0	0	0	7	1	0.00	0.00
	89																				1a-1	0	0	0	7.33	0.33	-0.50	0.50
	90																					0	0	0	6	-1.33	1.17	1.67
	91																					0	0	0	7	1	0.00	1.17
	92																					0	0	0	7	0	0.00	0.00
	93																				1a-1	0	0	0	7.33	0.33	0.50	0.50
	94																					0	0	0	6	-1.33	0.50	0.00
	95																					0	0	0	7	1	0.00	0.50
	96																					0	0	0	7	0	0.00	0.00
	97																					0	0	0	6	-1	0.50	0.50
	98																					0	0	0	7	1	0.00	0.50
	99																					0	0	0	7	0	-1.00	1.00
	100																					0	0	0	7	0	0.00	1.00
	101																				1a-1	0	0	0	7.33	0.33	-0.50	0.50
	102																					0	0	0	7	-0.33	0.00	0.50
	103																				6a	0	0	0	3	-4	-0.33	0.33
		0.00%	0.00%	0.63%	3.16%	3.16%	62.79%	97.14%	92.37%	87.62%	89.52%	91.43%	89.52%	27.59%	0.00%	6.03%	1.27%	0.00%	0.00%	0.00%								

Praeludium in C Major (BuxWV 138)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1																					0	0	0	7	0	0.00	0.00
	2																					0	0	0	7	0	0.00	0.00
	3																					0	0	0	7	0	0.00	0.00
	4																					0	0	0	7	0	1.00	1.00
	5																				1a-1	0	0	0	7.33	0.33	0.50	0.50
	6																				1a-1	0	0	0	7.33	0	-0.50	1.00
																						0	0	0	7	-0.33	0.00	0.50
																					2a	0	0	0	7	0	0.00	0.00
	8																				5b-1	0	0	0	6	-1	0.67	0.67
																					6a/1a-1	0	0	0	6.33	0.33	0.71	0.05
																					6a/2a	0	0	0	6	-0.33	-1.17	1.88
	10																					0	0	0	7	1	0.00	1.17
	11																					0	0	0	6	-1	-0.50	0.50
	12																				6a	0	0	0	5	-1	-0.60	0.10
	13																					0	0	0	6	1	-0.50	0.10
	14																				6a	0	0	0	6	0	-0.17	0.33
	15																				6a/1a-1	0	0	0	6.33	0.33	0.43	0.60
	16																				6a	0	0	0	6	-0.33	1.00	0.57
	17																				1a-1	0	0	0	7.33	1.33	0.50	0.50
	18																					0	0	0	7	-0.33	0.00	0.50
	19																					0	0	0	7	0	1.00	1.00
	20																					0	0	0	7	0	0.00	1.00
	21																					0	0	0	7	0	0.00	0.00
	22																				1b	0	0	0	7.33	0.33	0.50	0.50
	23																				4	0	0	0	5	-2.33	-0.60	1.10
	24																				6a	0	0	0	6	1	-0.17	0.43
	25																					0	0	0	7	1	1.00	1.17
	26																					0	0	0	7	0	0.00	1.00
	27																				6a	0	0	0	6	-1	-0.17	0.17
	28																					0	0	0	7	1	1.00	1.17
	29																					0	0	0	7	0	0.00	1.00
	30																				6a	0	0	0	6	-1	-0.17	0.17
	31																					0	0	0	7	1	1.00	1.17
	32																					0	0	0	7	0	0.00	1.00
	33																					0	0	0	7	0	-1.00	1.00
	34																					0	0	0	7	0	0.00	1.00
	35																					0	0	0	7	0	0.00	0.00
	36																				1a-1	0	0	0	7.33	0.33	0.50	0.50
	37																					0	0	0	7	-0.33	0.00	0.50
	38																					0	0	0	7	0	0.00	0.00
	39																					0	0	0	7	0	0.00	0.00
	40																				6a	0	0	0	5	-2	-0.80	0.80
	41																					0	0	0	7	2	0.00	0.80
	42																				6a	0	0	0	6	-1	-0.17	0.17
	43																				1a-1	0	0	0	7.33	1.33	-0.50	0.33
	44																				3a	0	0	0	7.66	0.33	0.63	1.13
	45																				3a	0	0	0	7.66	0	-0.50	1.13
	46																				1a-1	0	0	0	7.33	-0.33	0.38	0.88
	47																				3b	0	0	0	7.66	0.33	0.50	0.13
	48																					0	0	0	7	-0.66	0.00	0.50
	49																					0	0	0	7	0	0.00	0.00
	50																					0	0	0	7	0	0.00	0.00
	51																					0	0	0	7	0	0.00	0.00
	52																					0	0	0	7	0	0.00	0.00
	53																					0	0	0	7	0	1.00	1.00
	54																					0	0	0	7	0	0.00	1.00
	55																				1a-1	0	0	0	7.33	0.33	0.50	0.50
	56																					0	0	0	7	-0.33	0.00	0.50
	57																					0	0	0	7	0	0.00	0.00

Praeludium in C Major (BuxWV 138)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (A♭, D#, A#)	Active External Pitches (G♭, D♭, E#, B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	58																				1a-1	0	0	0	7.33	0.33	-0.50	0.50
	59																					0	0	0	7	-0.33	0.00	0.50
	60																					0	0	0	7	0	0.00	0.00
	61																					0	0	0	6	-1	-0.50	0.50
	62																					0	0	0	7	1	0.00	0.50
	63																				6a	0	0	0	6	-1	-0.17	0.17
	64																					0	0	0	7	1	1.00	1.17
	65																				1a-2	0	0	0	7.33	0.33	0.75	0.25
	66																				6a/1a-1	0	0	0	6.33	-1	-0.14	0.89
	67																					0	0	0	7	0.67	0.00	0.14
	68																					0	0	0	7	0	0.00	0.00
	69																				6a	0	0	0	6	-1	-0.17	0.17
		0.00%	0.00%	0.00%	0.00%	9.85%	82.61%	97.18%	97.18%	95.77%	85.92%	100%	83.55%	20.17%	3.75%	1.87%	0.00%	0.00%	0.00%	0.00%								

Praeludium in D Major (BuxWV 139)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1																				4	0	0	0	3	0	1.67	0.00
	2																				4	0	0	0	3	0	1.67	0.00
	3																				6b-1	0	0	0	5	2	1.20	0.47
	4																				6a	0	0	0	6	1	2.17	0.97
	5																				6a	0	0	0	6	0	1.67	0.50
	6																				6a	0	0	0	6	0	1.17	0.50
	7																				6a	0	0	0	6	0	1.83	0.67
	8																					0	0	0	7	1	3.00	1.17
	9																					0	0	0	7	0	3.00	0.00
	10																					0	0	0	6	-1	2.50	0.50
	11																				1a-1	1	0	1	7.33	1.33	3.38	0.88
	12																					0	0	0	6	-1.33	1.50	1.88
	13																				6a	0	0	0	6	0	3.33	1.83
	14																					0	0	0	7	1	2.00	1.33
	15																					0	0	0	7	0	2.00	0.00
	16																					0	0	0	6	-1	1.50	0.50
	17																				1a-1	0	0	0	7.33	1.33	1.50	0.00
	18																					0	0	0	7	-0.33	2.00	0.50
	19																				3a/1c-1	0	0	0	7.99	0.99	2.00	0.00
	20																				1b	0	0	0	7.33	-0.66	2.50	0.50
Fuga	21																				4	0	0	0	2	-5.33	3.50	1.00
	22																				4	0	0	0	4	2	1.50	2.00
	23																				6a	0	0	0	5	1	2.00	0.50
	24																				6a	0	0	0	6	1	2.00	0.00
	25																					0	0	0	7	1	3.00	1.00
	26																					0	0	0	7	0	2.00	1.00
	27																					0	0	0	7	0	2.00	0.00
	28																					0	0	0	7	0	2.00	0.00
	29																				1a-1	0	0	0	7.33	0.33	2.50	0.50
	30																				3a	1	0	1	7.66	0.33	3.50	1.00
	31																					0	0	0	7	-0.66	3.00	0.50
	32																					0	0	0	7	0	2.00	1.00
	33																				6a	0	0	0	5	-2	2.00	0.00
	34																				6a	0	0	0	5	0	2.60	0.60
	35																					0	0	0	7	2	3.00	0.40
	36																					0	0	0	7	0	2.00	1.00
	37																					0	0	0	7	0	2.00	0.00
	38																					0	0	0	6	-1	2.50	0.50
	39																					0	0	0	7	1	3.00	0.50
	40																					0	0	0	7	0	2.00	1.00
	41																					0	0	0	7	0	2.00	0.00
	42																					0	0	0	7	0	3.00	1.00
	43																					0	0	0	7	0	3.00	0.00
	44																					0	0	0	7	0	2.00	1.00
	45																					1	0	1	7	0	3.00	1.00
	46																					1	0	1	7	0	4.00	1.00
	47																					0	1	1	7	0	4.00	0.00
	48																					0	0	0	7	0	3.00	1.00
	49																					1	1	2	7	0	5.00	2.00
	50																					0	0	0	7	0	3.00	2.00
	51																					0	0	0	7	0	3.00	0.00
	52																					0	0	0	7	0	3.00	0.00
	53																					0	0	0	7	0	2.00	1.00
	54																					0	0	0	7	0	2.00	0.00
	55																					0	0	0	7	0	2.00	0.00
	56																				1a-1	0	0	0	7.33	0.33	2.50	0.50

Praeludium in D Major (BuxWV 139)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	57																					0	0	0	7	-0.33	2.00	0.50
	58																					0	0	0	7	0	2.00	0.00
	59																				6a	0	0	0	5	-2	1.20	0.80
	60																					0	0	0	7	2	2.00	0.80
	61																					0	0	0	7	0	2.00	0.00
Adagio	62																				6a	0	0	0	3	-4	2.33	0.33
	63																				6a	1	0	1	6	3	3.50	1.17
	64																					0	0	0	6	0	2.50	1.00
	65																				6a	0	0	0	6	0	2.83	0.33
	66																				6a	0	0	0	5	-1	2.60	0.23
	67																				6a	0	0	0	6	1	2.83	0.23
	68																					0	0	0	7	1	3.00	0.17
	69																				6a	0	0	0	3	-4	2.67	0.33
	70																					0	0	0	7	4	2.00	0.67
	71																					0	0	0	7	0	3.00	1.00
	72																					0	0	0	7	0	2.00	1.00
	73																					0	0	0	7	0	3.00	1.00
	74																					0	0	0	7	0	2.00	1.00
	75																					0	0	0	7	0	2.00	0.00
	76																					0	0	0	7	0	3.00	1.00
	77																					0	0	0	7	0	2.00	1.00
	78																					0	0	0	7	0	2.00	0.00
	79																				1a-1	0	0	0	7.33	0.33	1.50	0.50
	80																					0	0	0	7	-0.33	2.00	0.50
	81																					0	0	0	7	0	3.00	1.00
	82																				1a-2	0	0	0	7.33	0.33	2.50	0.50
	83																					0	0	0	7	-0.33	1.00	1.50
	84																					0	0	0	7	0	2.00	1.00
	85																					0	0	0	7	0	1.00	1.00
	86																					0	0	0	7	0	2.00	1.00
	87																				6a	1	0	1	3	-4	5.67	3.67
	88																				5b-1/5c-1	1	1	2	7	4	5.00	0.67
	89																				6a/6b-1	1	1	2	4	-3	6.75	1.75
	90																				6b-1	1	1	2	5	1	6.20	0.55
	91																				5b-1	0	1	1	6	1	4.67	1.53
	92																				5b-1	0	1	1	6	0	4.67	0.00
	93																				6a/6b-1	0	0	0	5	-1	2.20	2.47
	94																				6a	0	0	0	6	1	1.83	0.37
	95																				6a	0	0	0	6	0	0.83	1.00
	96																				6a	0	0	0	6	0	0.83	0.00
	97																				6a	0	0	0	5	-1	1.40	0.57
	98																				1a-1	0	0	0	7.33	2.33	1.50	0.10
	99																				6a	0	0	0	6	-1.33	0.83	0.67
	100																				6a	0	0	0	6	0	0.83	0.00
	101																					0	0	0	7	1	1.00	0.17
	102																					0	0	0	7	0	1.00	0.00
	103																				1a-1	0	0	0	7.33	0.33	1.50	0.50
	104																				6a	0	0	0	6	-1.33	2.00	0.50
	105																					0	0	0	7	1	1.00	1.00
	106																					0	0	0	7	0	2.00	1.00
	107																					0	0	0	7	0	2.00	0.00
	108																					0	0	0	7	0	2.00	0.00
	109																					0	0	0	7	0	2.00	0.00
	110																				6a	0	0	0	3	-4	1.67	0.33
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	11.81%	62.12%	88.18%	89.09%	80.91%	84.55%	95.45%	78.78%	29.98%	4.24%	4.55%	4.55%	1.82%								

Praeludium in D Minor (BuxWV 140)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1																					0	0	0	7	0	0.00	0.00
	2																					0	0	0	7	0	0.00	0.00
	3																					0	0	0	7	0	0.00	0.00
	4																				1a-2	0	0	0	7.33	0.33	-0.25	0.25
	5																					0	0	0	6	-1.33	-0.50	0.25
	6																					0	0	0	7	1	1.00	1.50
																					2a	0	0	0	6	-1	0.67	0.33
	7																					0	0	0	7	1	1.00	0.33
	8																				5b-1/3a	0	0	0	8.32	1.32	0.22	0.78
	9																				1a-2	0	0	0	7.33	-0.99	-0.25	0.47
	10																				1a-2	0	0	0	7.33	0	-0.25	0.00
	11																					0	0	0	7	-0.33	-1.00	0.75
	12																					0	0	0	7	0	-1.00	0.00
	13																				1c-2	0	0	0	7.33	0.33	-0.25	0.75
	14																					0	0	0	7	-0.33	-1.00	0.75
	15																					0	0	0	7	0	0.00	1.00
																					3c/2a	0	0	0	7.33	0.33	-0.38	0.38
	16																				1c-2	0	0	0	7.33	0	0.63	1.00
	17																				1a-2	0	0	0	7.33	0	-0.25	0.88
	18																					0	0	0	7	-0.33	-1.00	0.75
	19																				6b-2	0	0	0	5	-2	1.40	2.40
Fuga	20																					0	0	0	4	-1	-0.50	1.90
	21																				4	0	0	0	3	-1	-1.00	0.50
	22																				6a/3a	0	0	0	6.66	3.66	-0.14	0.86
	23																				6a	0	0	0	6	-0.66	0.00	0.14
	24																				3a	0	0	0	7.66	1.66	-1.50	1.50
	25																				1a-1	0	0	0	7.33	-0.33	-0.50	1.00
	26																				3a	0	0	0	7.66	0.33	-0.50	0.00
	27																					0	0	0	7	-0.66	0.00	0.50
	28																				3a	0	0	0	7.66	0.66	-1.50	1.50
	29																					0	0	0	7	-0.66	-1.00	0.50
	30																				3a	0	0	0	7.66	0.66	-0.50	0.50
	31																				6a/3a	0	0	0	6.66	-1	0.86	1.36
	32																				3a	0	0	0	7.66	1	-1.50	2.36
	33																				6a/1a-1	0	0	0	6.33	-1.33	-0.29	1.21
	34																				3a	0	0	0	7.66	1.33	-0.50	0.21
	35																					0	0	0	7	-0.66	-1.00	0.50
	36																					0	0	0	7	0	2.00	3.00
	37																				3a	0	0	0	7.66	0.66	-0.50	2.50
	38																				6a/1a-2	0	0	0	6.33	-1.33	0.86	1.36
	39																				1a-2	0	0	0	7.33	1	0.63	0.23
	40																				5b-1	0	0	0	7	-0.33	0.00	0.63
	41																				3a	0	0	0	7.66	0.66	-1.50	1.50
	42																				5b-1/1a-2	0	0	0	7.33	-0.33	-0.25	1.25
	43																				5c-2	0	0	0	7	-0.33	1.00	1.25
	44																				1a-1	0	0	0	7.33	0.33	2.50	1.50
	45																					0	0	0	7	-0.33	0.00	2.50
	46																				6a	0	0	0	5	-2	1.00	1.00
	47																				5b-1	0	0	0	7	2	0.00	1.00
	48																				6a	0	0	0	6	-1	-2.33	2.33
	49																				6a	0	0	0	5	-1	-1.60	0.73
	50																					0	0	0	7	2	-1.00	0.60
	51																					0	0	0	7	0	0.00	1.00
	52																					0	0	0	7	0	0.00	0.00
	53																				6a	0	0	0	6	-1	0.00	0.00
	54																					1	0	1	7	1	-1.00	1.00

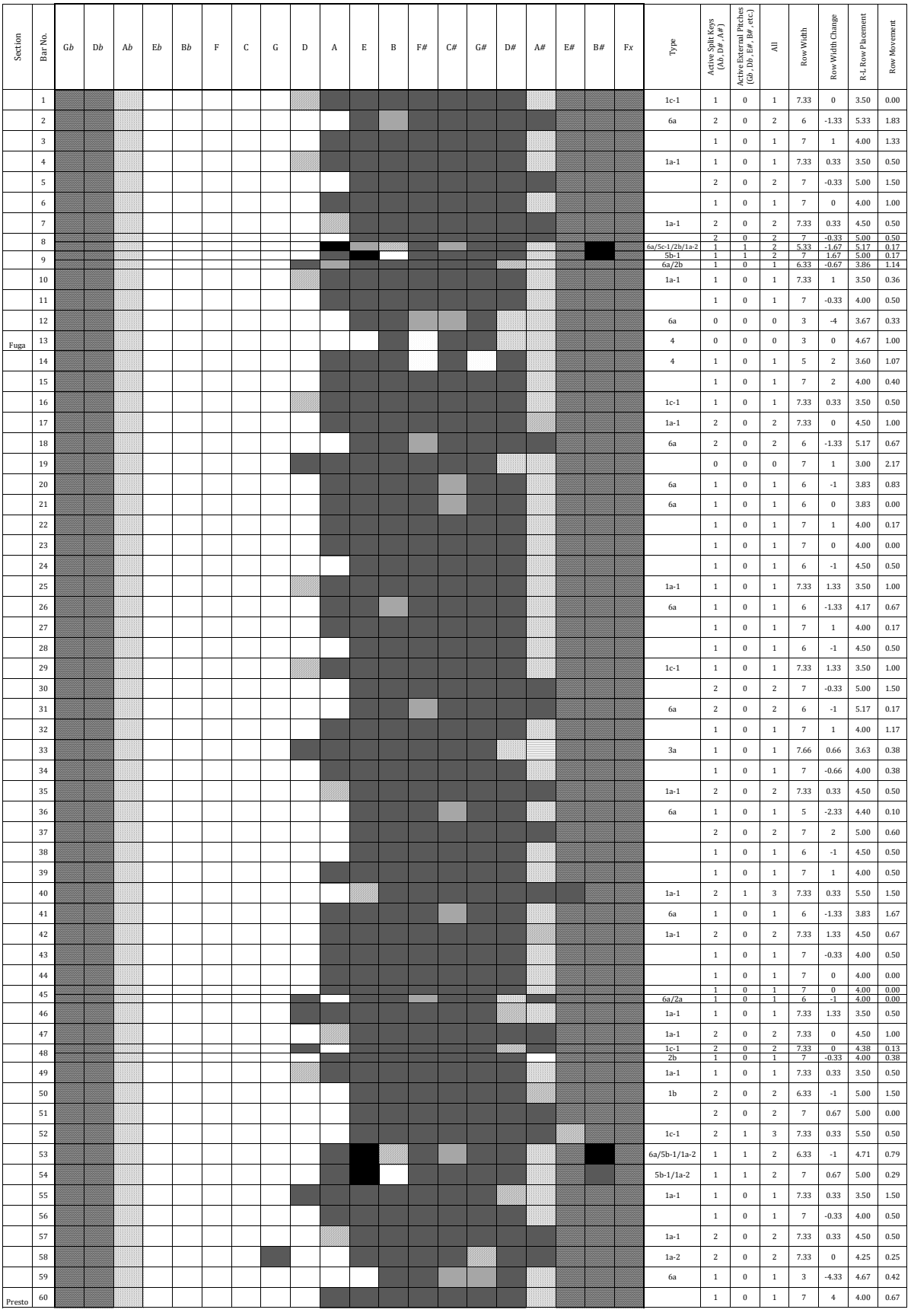
Praeludium in D Minor (BuxWV 140)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (A♭, D#, A#)	Active External Pitches (G♭, D♭, E#, B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	55																					0	0	0	6	-1	-0.50	0.50
	56																					0	0	0	7	1	-1.00	0.50
	57																				6b-2	0	0	0	6	-1	-0.83	0.17
	58																				5b-1/1a-2	0	0	0	7.33	1.33	-0.25	0.58
	59																				1a-1	0	0	0	7.33	0	-1.50	1.25
	60																				1a-1	1	0	1	7.33	0	-2.50	1.00
	61																					1	0	1	7	-0.33	-2.00	0.50
	62																				5b-1/5c-1/1a-2	0	0	0	7.33	0.33	0.38	2.38
	63																				6a/5b-1/3c/1a-2	0	0	0	6.33	-1	-0.14	0.52
	64																				6a	0	0	0	5	-1.33	1.00	1.14
	65																				6b-1	0	0	0	4	-1	0.00	1.00
	66																				6a/3a	0	0	0	4.66	0.66	-1.80	1.80
	67																				6a/1a-1	0	0	0	6.33	1.67	-0.29	1.51
	68																				6a	0	0	0	6	-0.33	1.17	1.45
	69																				6a/3b	0	0	0	5.66	-0.34	-1.17	2.33
	70																					0	0	0	7	1.34	0.00	1.17
	71																				6a	0	0	0	4	-3	-1.00	1.00
	72																				6a	0	0	0	6	2	-1.00	0.00
	73																				6a/3a	0	0	0	6.66	0.66	-1.71	0.71
	74																				6a	0	0	0	4	-2.66	-1.50	0.21
	75																				6a	0	0	0	3	-1	0.33	1.83
	76																				6a/3a	0	0	0	4.66	1.66	-0.80	1.13
	77																					0	0	0	6	1.34	0.67	1.47
	78																					0	0	0	6	0	-0.50	1.17
	79																				6a/3a	0	0	0	5.66	-0.34	-2.17	1.67
	80																				1a-2	0	0	0	7.33	1.67	-0.25	1.92
	81																				6a	0	0	0	4	-3.33	0.00	0.25
	82																				6a	0	0	0	3	-1	0.33	0.33
	83																				6a/3a	0	0	0	4.66	1.66	-0.80	1.13
	84																				6a	0	0	0	5	0.34	0.60	1.40
	85																				6a	0	0	0	5	0	-0.60	1.20
	86																				6a/3a	0	0	0	4.66	-0.34	-0.80	0.20
	87																				6a	0	0	0	5	0.34	-0.40	0.40
	88																					0	0	0	6	1	-0.33	0.07
	89																				6a	0	0	0	6	0	-1.17	0.83
	90																				6a	0	0	0	5	-1	-1.00	0.17
	91																				6a	0	0	0	3	-2	-1.33	0.33
	92																				6a/1a-1	0	0	0	4.33	1.33	-2.00	0.67
	93																				6a	0	0	0	4	-0.33	-1.50	0.50
	94																				6a	0	0	0	5	1	-1.60	0.10
	95																				6a	0	0	0	3	-2	-1.33	0.27
	96																				6a/3c	0	0	0	3.33	0.33	-1.50	0.17
	97																				6a/3c	0	0	0	4.33	1	-1.00	0.50
	98																					0	0	0	7	2.67	-1.00	0.00
	99																					0	0	0	6	-1	-0.50	0.50
	100																					0	0	0	7	1	-1.00	0.50
	101																				5b-1	0	0	0	7	0	1.00	2.00
	102																					0	0	0	7	0	0.00	1.00
	103																					0	0	0	7	0	0.00	0.00
	104																					0	0	0	7	0	0.00	0.00
	105																					0	0	0	7	0	-1.00	1.00
	106																				1a-1	0	0	0	7.33	0.33	-0.50	0.50
	107																				1a-1	0	0	0	7.33	0	-1.50	1.00
	108																					0	0	0	7	-0.33	-1.00	0.50
	109																				6a/1a-1	0	0	0	6.33	-0.67	-0.57	0.43
	110																				6a	0	0	0	6	-0.33	0.67	1.24

Praeludium in D Minor (BuxWV 140)

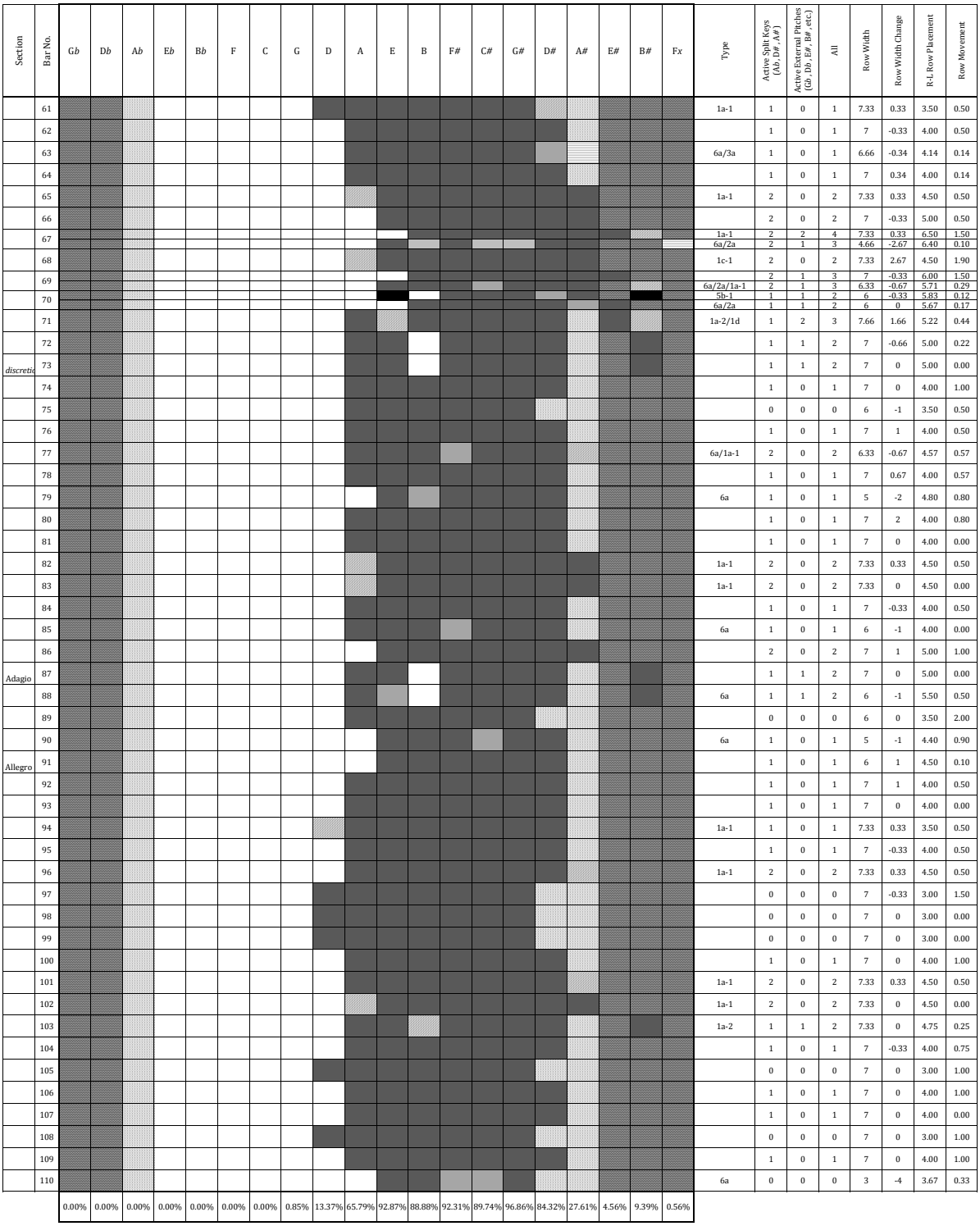
Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (A♭, D#, A#)	Active External Pitches (G♭, D♭, E#, B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	111																					0	0	0	7	1	-1.00	1.67
	112																					0	0	0	7	0	-1.00	0.00
	113																					0	0	0	7	0	-1.00	0.00
	114																					0	0	0	7	0	0.00	1.00
	115																					0	0	0	6	-1	-0.33	0.33
	116																					0	0	0	7	1	-1.00	0.67
	117																				5b-1/5c-1/1a-2	0	0	0	7.33	0.33	0.63	1.63
	118																					0	0	0	7	-0.33	0.00	0.63
	119																				1a-2	0	0	0	7.33	0.33	1.25	1.25
	120																				6a	0	0	0	3	-4.33	1.67	0.42
		0.00%	0.00%	2.46%	12.25%	61.14%	74.58%	70.48%	80.60%	86.89%	89.61%	78.68%	26.50%	18.30%	22.93%	3.28%	0.00%	0.00%	0.00%	0.00%								

Praeludium in E Major (BuxWV 141)



Section	Bar No.	Type	Active Split Keys (Ab, D#, A#)	Active External Pitches (Gb, Db, E#, B#, etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1	1c-1	1	0	1	7.33	0	3.50	0.00
	2	6a	2	0	2	6	-1.33	5.33	1.83
	3		1	0	1	7	1	4.00	1.33
	4	1a-1	1	0	1	7.33	0.33	3.50	0.50
	5		2	0	2	7	-0.33	5.00	1.50
	6		1	0	1	7	0	4.00	1.00
	7	1a-1	2	0	2	7.33	0.33	4.50	0.50
	8		2	0	2	7	-0.33	5.00	0.50
	9	6a/5c-1/2b/1a-2 5b-1 6a/2b	1 1 1	1 1 0	2 2 1	5.33 7 6.33	-1.67 1.67 -0.67	5.17 5.00 3.86	0.17 0.17 1.14
	10	1a-1	1	0	1	7.33	1	3.50	0.36
	11		1	0	1	7	-0.33	4.00	0.50
	12	6a	0	0	0	3	-4	3.67	0.33
Fuga	13	4	0	0	0	3	0	4.67	1.00
	14	4	1	0	1	5	2	3.60	1.07
	15		1	0	1	7	2	4.00	0.40
	16	1c-1	1	0	1	7.33	0.33	3.50	0.50
	17	1a-1	2	0	2	7.33	0	4.50	1.00
	18	6a	2	0	2	6	-1.33	5.17	0.67
	19		0	0	0	7	1	3.00	2.17
	20	6a	1	0	1	6	-1	3.83	0.83
	21	6a	1	0	1	6	0	3.83	0.00
	22		1	0	1	7	1	4.00	0.17
	23		1	0	1	7	0	4.00	0.00
	24		1	0	1	6	-1	4.50	0.50
	25	1a-1	1	0	1	7.33	1.33	3.50	1.00
	26	6a	1	0	1	6	-1.33	4.17	0.67
	27		1	0	1	7	1	4.00	0.17
	28		1	0	1	6	-1	4.50	0.50
	29	1c-1	1	0	1	7.33	1.33	3.50	1.00
	30		2	0	2	7	-0.33	5.00	1.50
	31	6a	2	0	2	6	-1	5.17	0.17
	32		1	0	1	7	1	4.00	1.17
	33	3a	1	0	1	7.66	0.66	3.63	0.38
	34		1	0	1	7	-0.66	4.00	0.38
	35	1a-1	2	0	2	7.33	0.33	4.50	0.50
	36	6a	1	0	1	5	-2.33	4.40	0.10
	37		2	0	2	7	2	5.00	0.60
	38		1	0	1	6	-1	4.50	0.50
	39		1	0	1	7	1	4.00	0.50
	40	1a-1	2	1	3	7.33	0.33	5.50	1.50
	41	6a	1	0	1	6	-1.33	3.83	1.67
	42	1a-1	2	0	2	7.33	1.33	4.50	0.67
	43		1	0	1	7	-0.33	4.00	0.50
	44		1	0	1	7	0	4.00	0.00
	45	6a/2a	1	0	1	6	-1	4.00	0.00
	46	1a-1	1	0	1	7.33	1.33	3.50	0.50
	47	1a-1	2	0	2	7.33	0	4.50	1.00
	48	1c-1 2b	2 1	0 0	2 1	7.33 7	0 -0.33	4.38 4.00	0.13 0.38
	49	1a-1	1	0	1	7.33	0.33	3.50	0.50
	50	1b	2	0	2	6.33	-1	5.00	1.50
	51		2	0	2	7	0.67	5.00	0.00
	52	1c-1	2	1	3	7.33	0.33	5.50	0.50
	53	6a/5b-1/1a-2	1	1	2	6.33	-1	4.71	0.79
	54	5b-1/1a-2	1	1	2	7	0.67	5.00	0.29
	55	1a-1	1	0	1	7.33	0.33	3.50	1.50
	56		1	0	1	7	-0.33	4.00	0.50
	57	1a-1	2	0	2	7.33	0.33	4.50	0.50
	58	1a-2	2	0	2	7.33	0	4.25	0.25
	59	6a	1	0	1	3	-4.33	4.67	0.42
Presto	60		1	0	1	7	4	4.00	0.67

Praeludium in E Major (BuxWV 141)



Section	Bar No.	Gb	Db	Ab	Eb	Bb	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Fx	Type	Active Split Keys (Ab, D#, A#)	Active External Pitches (Gb, Db, Eb, B#, etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	61																					1a-1	1	0	1	7.33	0.33	3.50	0.50
	62																						1	0	1	7	-0.33	4.00	0.50
	63																					6a/3a	1	0	1	6.66	-0.34	4.14	0.14
	64																						1	0	1	7	0.34	4.00	0.14
	65																					1a-1	2	0	2	7.33	0.33	4.50	0.50
	66																						2	0	2	7	-0.33	5.00	0.50
	67																					1a-1	2	2	4	7.33	0.33	6.50	1.50
																						6a/2a	2	1	3	4.66	-2.67	6.40	0.10
	68																					1c-1	2	0	2	7.33	2.67	4.50	1.90
	69																						2	1	3	7	-0.33	6.00	1.50
																						6a/2a/1a-1	2	1	3	6.33	-0.67	5.71	0.29
	70																					5b-1	1	1	2	6	-0.33	5.83	0.12
																						6a/2a	1	1	2	6	0	5.67	0.17
	71																					1a-2/1d	1	2	3	7.66	1.66	5.22	0.44
	72																						1	1	2	7	-0.66	5.00	0.22
discreti	73																						1	1	2	7	0	5.00	0.00
	74																						1	0	1	7	0	4.00	1.00
	75																						0	0	0	6	-1	3.50	0.50
	76																						1	0	1	7	1	4.00	0.50
	77																					6a/1a-1	2	0	2	6.33	-0.67	4.57	0.57
	78																						1	0	1	7	0.67	4.00	0.57
	79																					6a	1	0	1	5	-2	4.80	0.80
	80																						1	0	1	7	2	4.00	0.80
	81																						1	0	1	7	0	4.00	0.00
	82																					1a-1	2	0	2	7.33	0.33	4.50	0.50
	83																					1a-1	2	0	2	7.33	0	4.50	0.00
	84																						1	0	1	7	-0.33	4.00	0.50
	85																					6a	1	0	1	6	-1	4.00	0.00
	86																						2	0	2	7	1	5.00	1.00
Adagio	87																						1	1	2	7	0	5.00	0.00
	88																					6a	1	1	2	6	-1	5.50	0.50
	89																						0	0	0	6	0	3.50	2.00
	90																					6a	1	0	1	5	-1	4.40	0.90
Allegro	91																						1	0	1	6	1	4.50	0.10
	92																						1	0	1	7	1	4.00	0.50
	93																						1	0	1	7	0	4.00	0.00
	94																					1a-1	1	0	1	7.33	0.33	3.50	0.50
	95																						1	0	1	7	-0.33	4.00	0.50
	96																					1a-1	2	0	2	7.33	0.33	4.50	0.50
	97																						0	0	0	7	-0.33	3.00	1.50
	98																						0	0	0	7	0	3.00	0.00
	99																						0	0	0	7	0	3.00	0.00
	100																						1	0	1	7	0	4.00	1.00
	101																					1a-1	2	0	2	7.33	0.33	4.50	0.50
	102																					1a-1	2	0	2	7.33	0	4.50	0.00
	103																					1a-2	1	1	2	7.33	0	4.75	0.25
	104																						1	0	1	7	-0.33	4.00	0.75
	105																						0	0	0	7	0	3.00	1.00
	106																						1	0	1	7	0	4.00	1.00
	107																						1	0	1	7	0	4.00	0.00
	108																						0	0	0	7	0	3.00	1.00
	109																						1	0	1	7	0	4.00	1.00
	110																					6a	0	0	0	3	-4	3.67	0.33
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.85%	13.37%	65.79%	92.87%	88.88%	92.31%	89.74%	96.86%	84.32%	27.61%	4.56%	9.39%	0.56%								

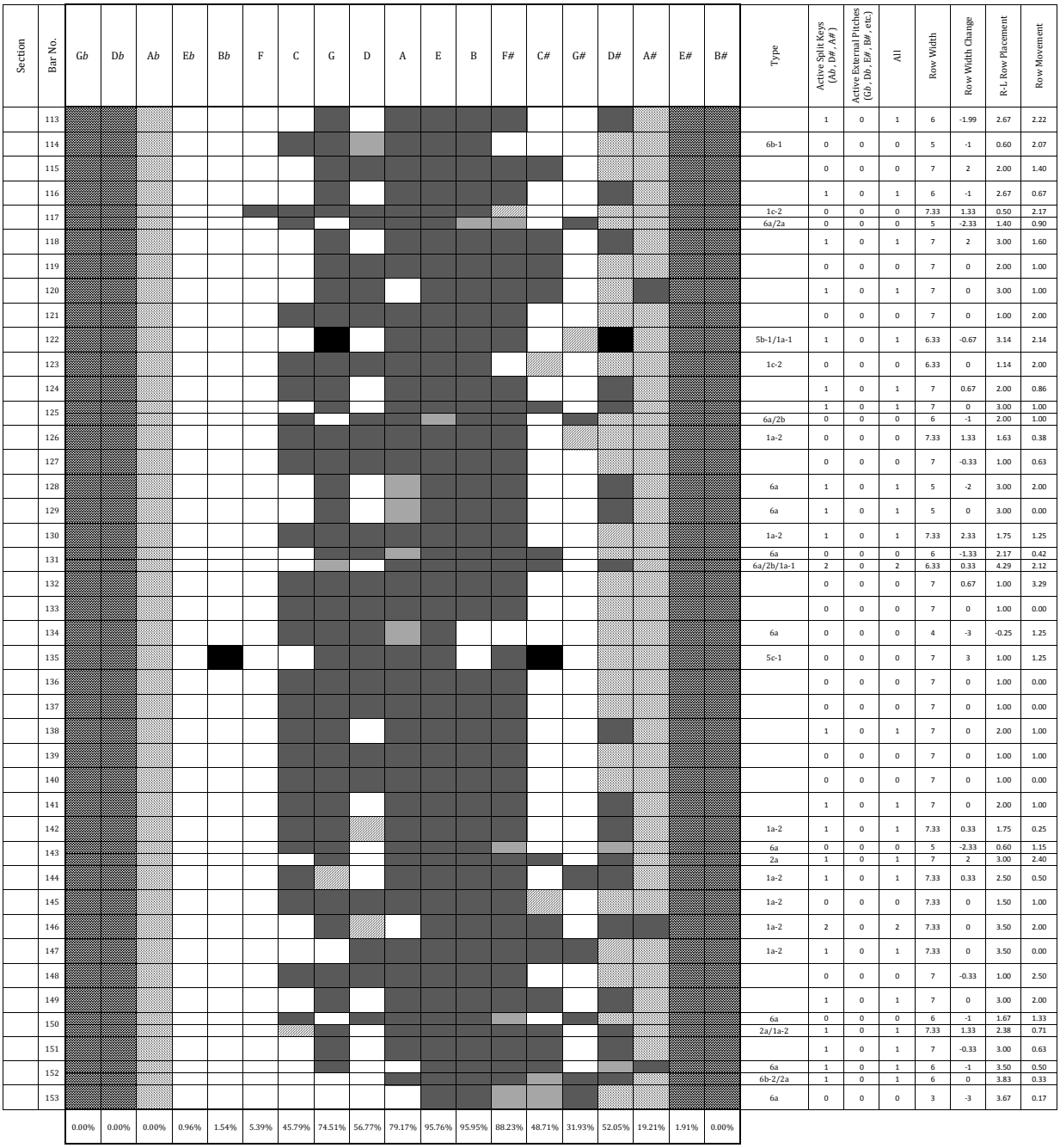
Praeludium in E Minor (BuxWV 142)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (A♭ , D# , A#)	Active External Pitches (G♭ , D♭ , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1																				1a-2	1	0	1	7.33	0	2.38	0.00
	2																				1c-2	1	0	1	7.33	0	2.38	0.00
	3																				1a-2	2	0	2	7.33	0	4.25	1.88
	4																				5b-1/1d	1	0	1	7.66	0.33	2.11	2.14
	5																					1	0	1	7	-0.66	2.00	0.11
	6																					0	0	0	7	0	1.00	1.00
	7																				1a-2	0	0	0	7.33	0.33	1.63	0.63
																					2a	1	0	1	6	-1.33	2.67	1.04
	8																					1	0	1	7	1	4.00	1.33
	9																					0	0	0	7	0	2.00	2.00
	10																				6a	0	0	0	6	-1	2.33	0.33
																					3c/2a/1d or 3c	0	0	0	7.66	1.66	1.00	1.33
	11																				5b-1/1c-2	0	0	0	6.33	-1.33	1.86	0.86
	12																				5b-1	1	0	1	6	-0.33	2.67	0.81
	13																				5b-1/1a-2	0	0	0	7.33	1.33	1.63	1.04
	14																					2	0	2	7.33	0	3.63	2.00
																					2a	1	0	1	7	-0.33	4.00	0.38
	15																				1a-2	1	0	1	7.33	0.33	2.63	1.38
	16																				3a	2	0	2	7.66	0.33	4.50	1.88
	17																					0	0	0	6	-1.66	1.50	3.00
	18																				6d/3a	1	0	1	6.66	0.66	2.43	0.93
	19																				6a/5b-1/3a	1	0	1	6.66	0	1.71	0.71
	20																				1a-2	1	0	1	7.33	0.67	1.75	0.04
	21																				3a/1c-2	2	0	2	7.99	0.66	3.22	1.47
	22																				5b-1/3a/1a-2	1	0	1	7.99	0	2.22	1.00
	23																				3a	1	0	1	7.66	-0.33	2.75	0.53
	24																					0	0	0	7	-0.66	1.00	1.75
	25																				3a	1	0	1	6.66	-0.34	2.29	1.29
	26																				5b-1	0	0	0	7	0.34	2.00	0.29
	27																				1c-2	0	0	0	7.33	0.33	1.63	0.38
	28																				3a	1	0	1	7.66	0.33	1.75	0.13
	29																				3a	0	0	0	7.66	0	1.38	0.38
	30																				3a	1	0	1	7.66	0	2.75	1.38
	31																				6a	1	0	1	6	-1.66	3.67	0.92
																					6a/5b-1/3a/2a	0	1	1	6.66	0.66	1.71	1.95
	32																				1a-2	1	0	1	7.33	0.67	1.75	0.04
	33																				1a-2	1	0	1	7.33	0	1.75	0.00
	34																				3a	0	0	0	7.66	0.33	0.50	1.25
	35																				3a	1	0	1	7.66	0	1.75	1.25
	36																				3a/1a-2	2	0	2	7.99	0.33	3.22	1.47
	37																				5b-1/1a-2	1	0	1	7.33	-0.66	3.38	0.15
	38																				5b-1/1a-2	1	0	1	7.33	0	1.75	1.63
	39																				5b-1/3a/1a-2	0	0	0	7.99	0.66	2.00	0.25
	40																				3a	1	0	1	7.66	-0.33	1.75	0.25
	41																				6a/3a	1	1	2	6.66	-1	5.29	3.54
																					2a/1a-2	1	0	1	6.33	-0.33	2.29	3.00
	42																				5b-1/1d	0	0	0	7.66	1.33	2.00	0.29
																					2a	0	0	0	7	-0.66	1.00	1.00
	43																				3a/1a-2	0	0	0	7.99	0.99	2.00	1.00
	44																				3a	1	0	1	6.66	-1.33	2.29	0.29
	45																				1a-2	1	0	1	7.33	0.67	1.75	0.54
	46																				6a/6b-1/3a	1	0	1	5.66	-1.67	2.00	0.25
																					6b-1/3a/2c	2	0	2	8.32	2.66	3.78	1.78
	47																				6a	0	0	0	3	-5.32	3.67	0.11
	48																				4/3a	1	0	1	4.32	1.32	2.40	1.27
	49																				6b-1/3a	2	0	2	7.32	3	3.88	1.48
	50																				3a	2	0	2	8.98	1.66	3.30	0.58
	51																				3a/1a-2	2	0	2	7.99	-0.99	3.89	0.59
	52																					1	0	1	6	-1.99	3.33	0.56
	53																				6a/3a	1	0	1	7.32	1.32	2.88	0.46
	54																				6a	1	0	1	5	-2.32	4.60	1.73
	55																				6a/3a	1	0	1	6.66	1.66	3.14	1.46
	56																				5c-1/3a/3b	1	0	1	8.32	1.66	2.11	1.03

Praeludium in E Minor (BuxWV 142)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (A♭ , D# , A#)	Active External Pitches (G♭ , D♭ , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	57																				1a-2	1	0	1	7.33	-0.99	3.38	1.26
	58																					1	0	1	6	-1.33	2.67	0.71
	59																				6a	2	0	2	6	0	5.17	2.50
	60																				3a/1c-2	2	0	2	8.65	2.65	3.30	1.87
	61																				6a	1	0	1	5	-3.65	3.00	0.30
	62																				3a	1	0	1	8.32	3.32	2.89	0.11
	63																					1	0	1	7	-1.32	4.00	1.11
	64																				5c-1/3a	2	1	3	8.32	1.32	4.89	0.89
	65																				5b-1/3a	1	0	1	7.66	-0.66	3.38	1.51
	66																					1	0	1	7	-0.66	3.00	0.38
	67																				3a/3b	1	0	1	8.32	1.32	2.11	0.89
	68																				3a	1	0	1	8.98	0.66	2.50	0.39
	69																				1a-2	1	0	1	7.33	-1.65	2.38	0.13
	70																				3a	1	0	1	8.32	0.99	3.11	0.74
	71																				5b-1/3a	1	0	1	6.66	-1.66	2.29	0.83
	72																				3a/1a-2	1	0	1	8.65	1.99	2.60	0.31
	73																				6a/5b-1/3a	0	0	0	6.66	-1.99	1.71	0.89
	74																				3a	1	0	1	8.32	1.66	1.89	0.17
	75																				6a/6b-1/3a	1	0	1	5.66	-2.66	3.50	1.61
																					6b-1/2a	2	0	2	6	0.34	5.00	1.50
	76																				3a/1a-1	2	0	2	8.65	2.65	2.70	2.30
	77																				5b-1/3b	1	0	1	8.98	0.33	2.50	0.20
	78																				3a/1a-1	2	0	2	8.65	-0.33	3.20	0.70
	79																				3a/1c-2	2	1	3	8.65	0	4.50	1.30
																					2c	2	0	2	7	-1.65	5.00	0.50
	80																				1a-2	2	0	2	7.33	0.33	3.63	1.38
	81																				1a-1	0	0	0	7.33	0	1.50	2.13
	82																				6a	0	0	0	6	-1.33	1.17	0.33
																					2a	1	0	1	7	1	3.00	1.83
	83																				3a/1a-2	1	0	1	8.65	1.65	2.60	0.40
	84																				5b-1/3a	1	0	1	6.66	-1.99	2.29	0.31
	85																				3a/1a-2	0	0	0	8.65	1.99	0.40	1.89
	86																				1a-1	0	0	0	7.33	-1.32	1.50	1.10
	87																				3a	0	0	0	8.32	0.99	0.89	0.61
	88																					0	0	0	4	-4.32	-0.50	1.39
																					2a	0	0	0	7	3	-1.00	0.50
	89																				1a-2	1	0	1	7.33	0.33	2.63	3.63
	90																				3a/3b	1	0	1	8.32	0.99	2.11	0.51
	91																				3a/1a-2	1	0	1	8.65	0.33	2.50	0.39
	92																				5c-1/3a	2	0	2	8.32	-0.33	3.89	1.39
	93																					1	0	1	7	-1.32	4.00	0.11
																					6a/2a	0	0	0	6	-1	1.50	2.50
	94																				5b-1/3a/1a-2	1	0	1	8.65	2.65	2.50	1.00
	95																				3a/1a-2	1	0	1	8.65	0	2.60	0.10
	96																				5b-1/3a	2	0	2	7.99	-0.66	3.22	0.62
																					6a/3a/2a	1	0	1	4.66	-3.33	4.00	0.78
	97																				3a	1	0	1	8.98	4.32	2.50	1.50
	98																				5b-1/3a/1a-2	2	0	2	8.65	-0.33	3.50	1.00
	99																				5b-1/1b	2	1	3	7.33	-1.32	4.63	1.13
	100																				6a	1	0	1	3	-4.33	4.67	0.04
	101																				6b-1/*/1d	0	0	0	6.66	3.66	2.13	2.54
	102																					0	0	0	7	0.34	3.00	0.88
	103																					0	0	0	6	-1	1.67	1.33
																					2a	0	0	0	7	1	1.00	0.67
	104																					0	0	0	7	0	0.00	1.00
	105																				5b-1/3a	0	0	0	7.66	0.66	1.38	1.38
	106																				6a	0	0	0	5	-2.66	1.40	0.02
	107																					1	0	1	7	2	3.00	1.60
	108																				6a/5b-1	1	0	1	6	-1	1.67	1.33
	109																				6b-1	1	0	1	6	0	3.83	2.17
	110																				6b-1/5b-1/1d	1	0	1	6.66	0.66	2.25	1.58
	111																				6b-1/3a	2	0	2	6.66	0	4.14	1.89
	112																				5b-1/3a/1a-1	2	1	3	7.99	1.33	4.89	0.75

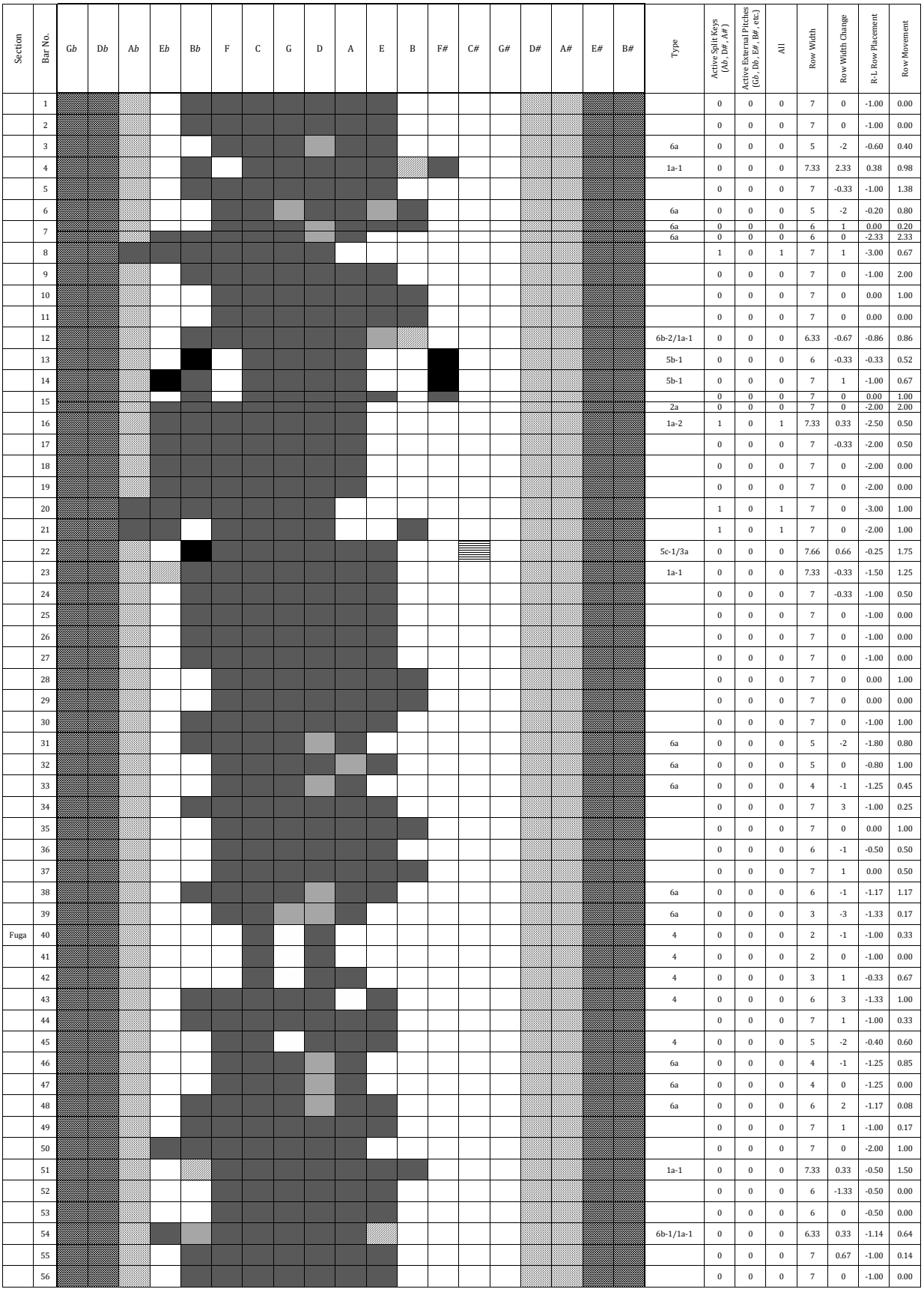
Praeludium in E Minor (BuxWV 142)



Section	Bar No.	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	113		1	0	1	6	-1.99	2.67	2.22
	114	6b-1	0	0	0	5	-1	0.60	2.07
	115		0	0	0	7	2	2.00	1.40
	116		1	0	1	6	-1	2.67	0.67
	117	1c-2	0	0	0	7.33	1.33	0.50	2.17
		6a/2a	0	0	0	5	-2.33	1.40	0.90
	118		1	0	1	7	2	3.00	1.60
	119		0	0	0	7	0	2.00	1.00
	120		1	0	1	7	0	3.00	1.00
	121		0	0	0	7	0	1.00	2.00
	122	5b-1/1a-1	1	0	1	6.33	-0.67	3.14	2.14
	123	1c-2	0	0	0	6.33	0	1.14	2.00
	124		1	0	1	7	0.67	2.00	0.86
	125		1	0	1	7	0	3.00	1.00
		6a/2b	0	0	0	6	-1	2.00	1.00
	126	1a-2	0	0	0	7.33	1.33	1.63	0.38
	127		0	0	0	7	-0.33	1.00	0.63
	128	6a	1	0	1	5	-2	3.00	2.00
	129	6a	1	0	1	5	0	3.00	0.00
	130	1a-2	1	0	1	7.33	2.33	1.75	1.25
	131	6a	0	0	0	6	-1.33	2.17	0.42
		6a/2b/1a-1	2	0	2	6.33	0.33	4.29	2.12
	132		0	0	0	7	0.67	1.00	3.29
	133		0	0	0	7	0	1.00	0.00
	134	6a	0	0	0	4	-3	-0.25	1.25
	135	5c-1	0	0	0	7	3	1.00	1.25
	136		0	0	0	7	0	1.00	0.00
	137		0	0	0	7	0	1.00	0.00
	138		1	0	1	7	0	2.00	1.00
	139		0	0	0	7	0	1.00	1.00
	140		0	0	0	7	0	1.00	0.00
	141		1	0	1	7	0	2.00	1.00
	142	1a-2	1	0	1	7.33	0.33	1.75	0.25
	143	6a	0	0	0	5	-2.33	0.60	1.15
		2a	1	0	1	7	2	3.00	2.40
	144	1a-2	1	0	1	7.33	0.33	2.50	0.50
	145	1a-2	0	0	0	7.33	0	1.50	1.00
	146	1a-2	2	0	2	7.33	0	3.50	2.00
	147	1a-2	1	0	1	7.33	0	3.50	0.00
	148		0	0	0	7	-0.33	1.00	2.50
	149		1	0	1	7	0	3.00	2.00
	150	6a	0	0	0	6	-1	1.67	1.33
		2a/1a-2	1	0	1	7.33	1.33	2.38	0.71
	151		1	0	1	7	-0.33	3.00	0.63
	152	6a	1	0	1	6	-1	3.50	0.50
		6b-2/2a	1	0	1	6	0	3.83	0.33
	153	6a	0	0	0	3	-3	3.67	0.17

Gb	Db	Ab	Eb	Bb	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#
0.00%	0.00%	0.00%	0.96%	1.54%	5.39%	45.79%	74.51%	56.77%	79.17%	95.76%	95.95%	88.23%	48.71%	31.93%	52.05%	19.21%	1.91%	0.00%

Praeludium in F Major (Bux WV 145)

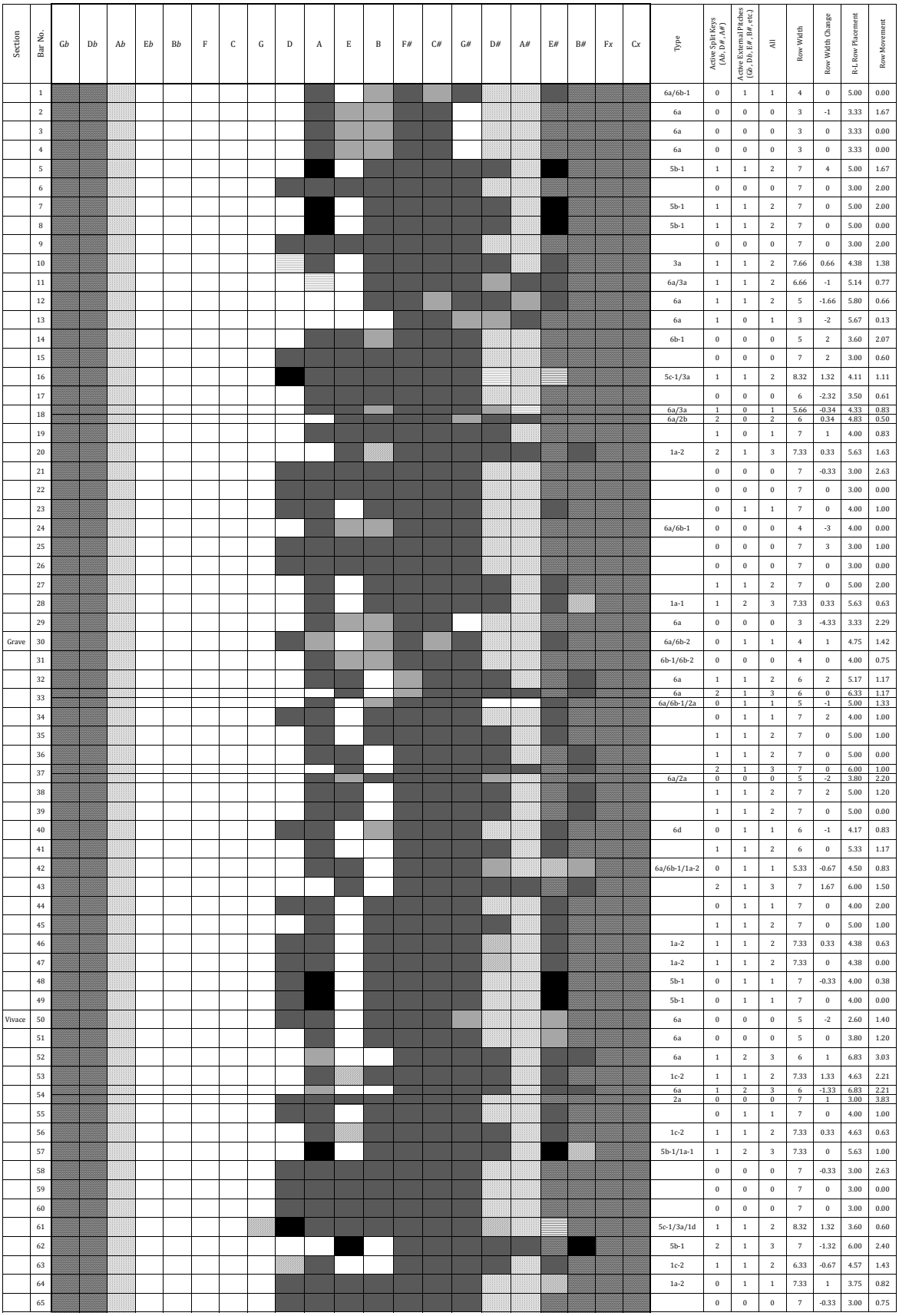


Section	Bar No.	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1		0	0	0	7	0	-1.00	0.00
	2		0	0	0	7	0	-1.00	0.00
	3	6a	0	0	0	5	-2	-0.60	0.40
	4	1a-1	0	0	0	7.33	2.33	0.38	0.98
	5		0	0	0	7	-0.33	-1.00	1.38
	6	6a	0	0	0	5	-2	-0.20	0.80
	7	6a	0	0	0	6	1	0.00	0.20
		6a	0	0	0	6	0	-2.33	2.33
	8		1	0	1	7	1	-3.00	0.67
	9		0	0	0	7	0	-1.00	2.00
	10		0	0	0	7	0	0.00	1.00
	11		0	0	0	7	0	0.00	0.00
	12	6b-2/1a-1	0	0	0	6.33	-0.67	-0.86	0.86
	13	5b-1	0	0	0	6	-0.33	-0.33	0.52
	14	5b-1	0	0	0	7	1	-1.00	0.67
	15		0	0	0	7	0	0.00	1.00
		2a	0	0	0	7	0	-2.00	2.00
	16	1a-2	1	0	1	7.33	0.33	-2.50	0.50
	17		0	0	0	7	-0.33	-2.00	0.50
	18		0	0	0	7	0	-2.00	0.00
	19		0	0	0	7	0	-2.00	0.00
	20		1	0	1	7	0	-3.00	1.00
	21		1	0	1	7	0	-2.00	1.00
	22	5c-1/3a	0	0	0	7.66	0.66	-0.25	1.75
	23	1a-1	0	0	0	7.33	-0.33	-1.50	1.25
	24		0	0	0	7	-0.33	-1.00	0.50
	25		0	0	0	7	0	-1.00	0.00
	26		0	0	0	7	0	-1.00	0.00
	27		0	0	0	7	0	-1.00	0.00
	28		0	0	0	7	0	0.00	1.00
	29		0	0	0	7	0	0.00	0.00
	30		0	0	0	7	0	-1.00	1.00
	31	6a	0	0	0	5	-2	-1.80	0.80
	32	6a	0	0	0	5	0	-0.80	1.00
	33	6a	0	0	0	4	-1	-1.25	0.45
	34		0	0	0	7	3	-1.00	0.25
	35		0	0	0	7	0	0.00	1.00
	36		0	0	0	6	-1	-0.50	0.50
	37		0	0	0	7	1	0.00	0.50
	38	6a	0	0	0	6	-1	-1.17	1.17
	39	6a	0	0	0	3	-3	-1.33	0.17
Fuga	40	4	0	0	0	2	-1	-1.00	0.33
	41	4	0	0	0	2	0	-1.00	0.00
	42	4	0	0	0	3	1	-0.33	0.67
	43	4	0	0	0	6	3	-1.33	1.00
	44		0	0	0	7	1	-1.00	0.33
	45	4	0	0	0	5	-2	-0.40	0.60
	46	6a	0	0	0	4	-1	-1.25	0.85
	47	6a	0	0	0	4	0	-1.25	0.00
	48	6a	0	0	0	6	2	-1.17	0.08
	49		0	0	0	7	1	-1.00	0.17
	50		0	0	0	7	0	-2.00	1.00
	51	1a-1	0	0	0	7.33	0.33	-0.50	1.50
	52		0	0	0	6	-1.33	-0.50	0.00
	53		0	0	0	6	0	-0.50	0.00
	54	6b-1/1a-1	0	0	0	6.33	0.33	-1.14	0.64
	55		0	0	0	7	0.67	-1.00	0.14
	56		0	0	0	7	0	-1.00	0.00

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	57																					0	0	0	7	0	-1.00	0.00
	58																				6a	0	0	0	5	-2	-0.60	0.40
	59																				6a	0	0	0	5	0	-0.60	0.00
	60																				6a	0	0	0	5	0	-0.60	0.00
	61																				1a-1	0	0	0	7.33	2.33	-0.50	0.10
	62																					0	0	0	7	-0.33	-2.00	1.50
	63																				1a-1	0	0	0	7.33	0.33	-0.50	1.50
	64																					0	0	0	6	-1.33	-0.50	0.00
	65																				6a	0	0	0	5	-1	-0.80	0.30
	66																				6a	0	0	0	5	0	-1.80	1.00
	67																					0	0	0	6	1	-1.50	0.30
	68																					0	0	0	6	0	-1.50	0.00
	69																					0	0	0	7	1	-1.00	0.50
	70																					0	0	0	7	0	-1.00	0.00
	71																					0	0	0	7	0	-2.00	1.00
	72																				1a-1	0	0	0	7.33	0.33	0.50	2.50
	73																					0	0	0	6	-1.33	-0.50	1.00
	74																					0	0	0	6	0	-0.50	0.00
	75																				6b-1/1a-1	0	0	0	6.33	0.33	-1.14	0.64
	76																					0	0	0	7	0.67	-1.00	0.14
	77																					0	0	0	7	0	-1.00	0.00
	78																					0	0	0	7	0	-1.00	0.00
	79																					0	0	0	5	-2	-1.00	0.00
	80																					0	0	0	5	0	-1.00	0.00
	81																				6a	0	0	0	6	1	-1.17	0.17
	82																				1a-1	0	0	0	7.33	1.33	-0.50	0.67
	83																				1a-1	0	0	0	7.33	0	-1.50	1.00
	84																					0	0	0	7	-0.33	0.00	1.50
	85																				6a	0	0	0	4	-3	-0.25	0.25
	86																				6a	0	0	0	4	0	-0.25	0.00
	87																					0	0	0	6	2	-0.50	0.25
	88																					0	0	0	7	1	-1.00	0.50
	89																					0	0	0	7	0	-1.00	0.00
	90																					0	0	0	6	-1	-0.50	0.50
	91																					0	0	0	6	0	-0.50	0.00
	92																					0	0	0	5	-1	0.00	0.50
	93																				6b-1/1a-1	0	0	0	6.33	1.33	-1.14	1.14
	94																				1a-1	0	0	0	7.33	1	-1.50	0.36
	95																					0	0	0	7	-0.33	-1.00	0.50
	96																					0	0	0	7	0	-1.00	0.00
	97																				6a	0	0	0	4	-3	-1.25	0.25
	98																				6a	0	0	0	4	0	-1.25	0.00
	99																				6a	0	0	0	4	0	-1.25	0.00
	100																					0	0	0	7	3	-1.00	0.25
	101																					0	0	0	7	0	-1.00	0.00
	102																					0	0	0	7	0	-1.00	0.00
	103																					0	0	0	7	0	-1.00	0.00
	104																					0	0	0	6	-1	-0.50	0.50
	105																					0	0	0	6	0	-0.50	0.00
	106																				1a-1	0	0	0	7.33	1.33	-1.50	1.00
	107																					0	0	0	7	-0.33	-2.00	0.50
	108																					0	0	0	7	0	-1.00	1.00
	109																					0	0	0	7	0	0.00	1.00
	110																					0	0	0	6	-1	-1.50	1.50
	111																					0	0	0	7	1	-2.00	0.50
	112																				1a-1	0	0	0	7.33	0.33	-1.50	0.50

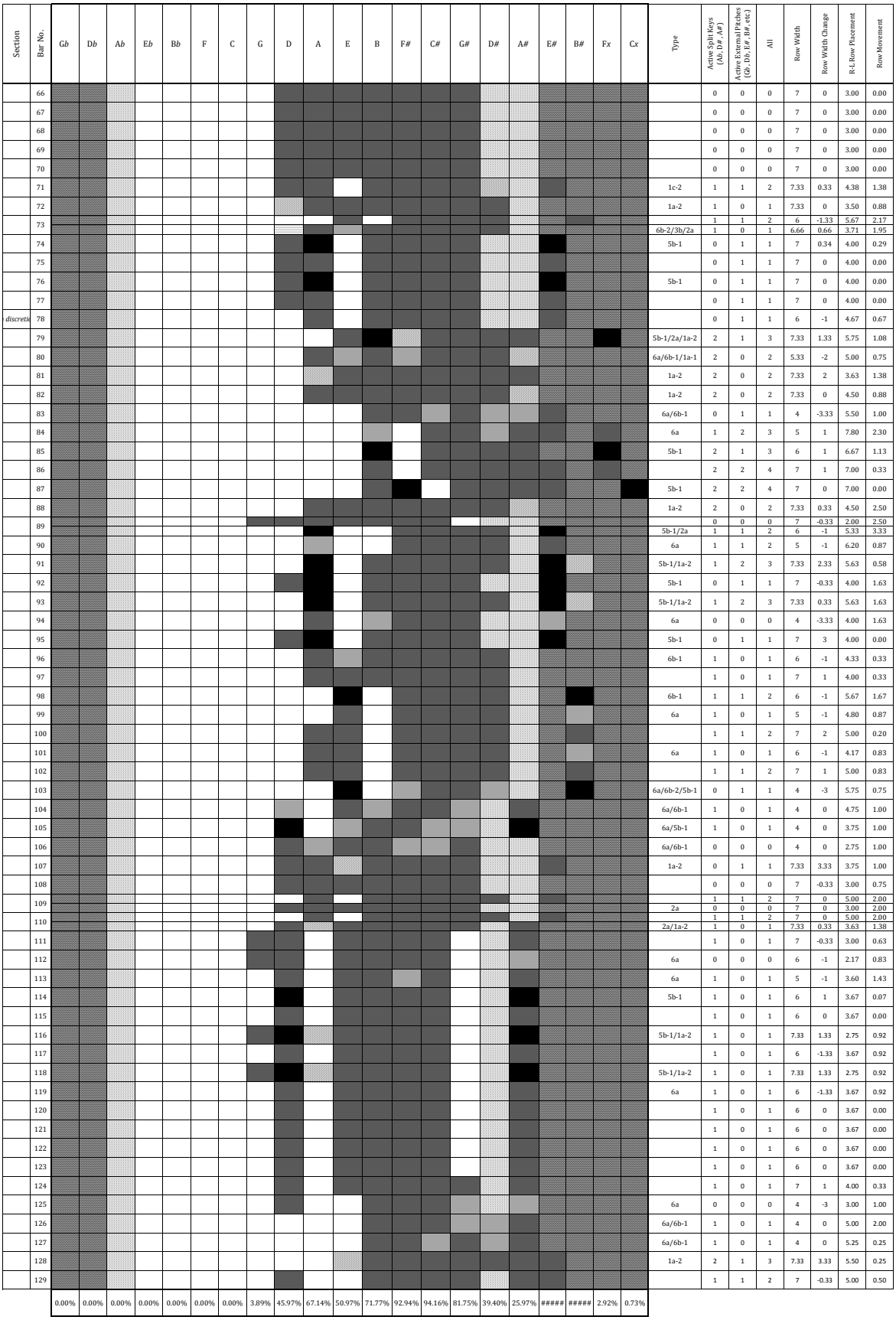
Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (A♭ , D# , A#)	Active External Pitches (G♭ , D♭ , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	113																					0	0	0	7	-0.33	-1.00	0.50
	114																					0	0	0	7	0	-1.00	0.00
	115																					0	0	0	6	-1	-1.50	0.50
	116																					0	0	0	6	0	-0.50	1.00
	117																				6a/1c-1	0	0	0	6.33	0.33	-0.43	0.07
	118																					0	0	0	5	-1.33	0.00	0.43
	119																					0	0	0	5	0	0.00	0.00
	120																					0	0	0	6	1	-1.50	1.50
	121																					0	0	0	7	1	-1.00	0.50
	122																				1a-1	0	0	0	7.33	0.33	-0.50	0.50
	123																					0	0	0	7	-0.33	0.00	0.50
	124																					0	0	0	7	0	-1.00	1.00
	125																				5b-1	1	0	1	7	0	-2.00	1.00
	126																					0	0	0	7	0	-2.00	0.00
	127																					0	0	0	7	0	-1.00	1.00
		0.00%	0.00%	3.36%	17.05%	58.39%	90.18%	99.22%	94.57%	86.05%	91.47%	67.95%	13.43%	3.88%	1.29%	0.00%	0.00%	0.00%	0.00%	0.00%								

Praeludium in F-Sharp Minor (BuxWV 146)



Section	Bar No.	Type	Active Split Keys (Ab, D#, A#)	Active External Pitches (Gb, Db, E#, B#, etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1	6a/6b-1	0	1	1	4	0	5.00	0.00
	2	6a	0	0	0	3	-1	3.33	1.67
	3	6a	0	0	0	3	0	3.33	0.00
	4	6a	0	0	0	3	0	3.33	0.00
	5	5b-1	1	1	2	7	4	5.00	1.67
	6		0	0	0	7	0	3.00	2.00
	7	5b-1	1	1	2	7	0	5.00	2.00
	8	5b-1	1	1	2	7	0	5.00	0.00
	9		0	0	0	7	0	3.00	2.00
	10	3a	1	1	2	7.66	0.66	4.38	1.38
	11	6a/3a	1	1	2	6.66	-1	5.14	0.77
	12	6a	1	1	2	5	-1.66	5.80	0.66
	13	6a	1	0	1	3	-2	5.67	0.13
	14	6b-1	0	0	0	5	2	3.60	2.07
	15		0	0	0	7	2	3.00	0.60
	16	5c-1/3a	1	1	2	8.32	1.32	4.11	1.11
	17		0	0	0	6	-2.32	3.50	0.61
	18	6a/3a	1	0	1	5.66	-0.34	4.33	0.83
		6a/2b	2	0	2	6	0.34	4.83	0.50
	19		1	0	1	7	1	4.00	0.83
	20	1a-2	2	1	3	7.33	0.33	5.63	1.63
	21		0	0	0	7	-0.33	3.00	2.63
	22		0	0	0	7	0	3.00	0.00
	23		0	1	1	7	0	4.00	1.00
	24	6a/6b-1	0	0	0	4	-3	4.00	0.00
	25		0	0	0	7	3	3.00	1.00
	26		0	0	0	7	0	3.00	0.00
	27		1	1	2	7	0	5.00	2.00
	28	1a-1	1	2	3	7.33	0.33	5.63	0.63
	29	6a	0	0	0	3	-4.33	3.33	2.29
Grave	30	6a/6b-2	0	1	1	4	1	4.75	1.42
	31	6b-1/6b-2	0	0	0	4	0	4.00	0.75
	32	6a	1	1	2	6	2	5.17	1.17
	33	6a	2	1	3	6	0	6.33	1.17
		6a/6b-1/2a	0	1	1	5	-1	5.00	1.33
	34		0	1	1	7	2	4.00	1.00
	35		1	1	2	7	0	5.00	1.00
	36		1	1	2	7	0	5.00	0.00
	37		2	1	3	7	0	6.00	1.00
		6a/2a	0	0	0	5	-2	3.80	2.20
	38		1	1	2	7	2	5.00	1.20
	39		1	1	2	7	0	5.00	0.00
	40	6d	0	1	1	6	-1	4.17	0.83
	41		1	1	2	6	0	5.33	1.17
	42	6a/6b-1/1a-2	0	1	1	5.33	-0.67	4.50	0.83
	43		2	1	3	7	1.67	6.00	1.50
	44		0	1	1	7	0	4.00	2.00
	45		1	1	2	7	0	5.00	1.00
	46	1a-2	1	1	2	7.33	0.33	4.38	0.63
	47	1a-2	1	1	2	7.33	0	4.38	0.00
	48	5b-1	0	1	1	7	-0.33	4.00	0.38
	49	5b-1	0	1	1	7	0	4.00	0.00
Vivace	50	6a	0	0	0	5	-2	2.60	1.40
	51	6a	0	0	0	5	0	3.80	1.20
	52	6a	1	2	3	6	1	6.83	3.03
	53	1c-2	1	1	2	7.33	1.33	4.63	2.21
	54	6a	1	2	3	6	-1.33	6.83	2.21
		2a	0	0	0	7	1	3.00	3.83
	55		0	1	1	7	0	4.00	1.00
	56	1c-2	1	1	2	7.33	0.33	4.63	0.63
	57	5b-1/1a-1	1	2	3	7.33	0	5.63	1.00
	58		0	0	0	7	-0.33	3.00	2.63
	59		0	0	0	7	0	3.00	0.00
	60		0	0	0	7	0	3.00	0.00
	61	5c-1/3a/1d	1	1	2	8.32	1.32	3.60	0.60
	62	5b-1	2	1	3	7	-1.32	6.00	2.40
	63	1c-2	1	1	2	6.33	-0.67	4.57	1.43
	64	1a-2	0	1	1	7.33	1	3.75	0.82
	65		0	0	0	7	-0.33	3.00	0.75

Praeludium in F-Sharp Minor (BuxWV 146)



Section	Bar No.	Gb	Db	Ab	Eb	Bb	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Fx	Cx	Type	Active Split Keys (Ab, D#, A#)	Active External Pitches (Gb, Db, E#, B#, etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	66																							0	0	0	7	0	3.00	0.00
	67																							0	0	0	7	0	3.00	0.00
	68																							0	0	0	7	0	3.00	0.00
	69																							0	0	0	7	0	3.00	0.00
	70																							0	0	0	7	0	3.00	0.00
	71																						1c-2	1	1	2	7.33	0.33	4.38	1.38
	72																						1a-2	1	0	1	7.33	0	3.50	0.88
	73																							1	1	2	6	-1.33	5.67	2.17
																							6b-2/3b/2a	1	0	1	6.66	0.66	3.71	1.95
	74																						5b-1	0	1	1	7	0.34	4.00	0.29
	75																							0	1	1	7	0	4.00	0.00
	76																						5b-1	0	1	1	7	0	4.00	0.00
	77																							0	1	1	7	0	4.00	0.00
discreti	78																							0	1	1	6	-1	4.67	0.67
	79																						5b-1/2a/1a-2	2	1	3	7.33	1.33	5.75	1.08
	80																						6a/6b-1/1a-1	2	0	2	5.33	-2	5.00	0.75
	81																						1a-2	2	0	2	7.33	2	3.63	1.38
	82																						1a-2	2	0	2	7.33	0	4.50	0.88
	83																						6a/6b-1	0	1	1	4	-3.33	5.50	1.00
	84																						6a	1	2	3	5	1	7.80	2.30
	85																						5b-1	2	1	3	6	1	6.67	1.13
	86																							2	2	4	7	1	7.00	0.33
	87																						5b-1	2	2	4	7	0	7.00	0.00
	88																						1a-2	2	0	2	7.33	0.33	4.50	2.50
	89																							0	0	0	7	-0.33	2.00	2.50
																							5b-1/2a	1	1	2	6	-1	5.33	3.33
	90																						6a	1	1	2	5	-1	6.20	0.87
	91																						5b-1/1a-2	1	2	3	7.33	2.33	5.63	0.58
	92																						5b-1	0	1	1	7	-0.33	4.00	1.63
	93																						5b-1/1a-2	1	2	3	7.33	0.33	5.63	1.63
	94																						6a	0	0	0	4	-3.33	4.00	1.63
	95																						5b-1	0	1	1	7	3	4.00	0.00
	96																						6b-1	1	0	1	6	-1	4.33	0.33
	97																							1	0	1	7	1	4.00	0.33
	98																						6b-1	1	1	2	6	-1	5.67	1.67
	99																						6a	1	0	1	5	-1	4.80	0.87
	100																							1	1	2	7	2	5.00	0.20
	101																						6a	1	0	1	6	-1	4.17	0.83
	102																							1	1	2	7	1	5.00	0.83
	103																						6a/6b-2/5b-1	0	1	1	4	-3	5.75	0.75
	104																						6a/6b-1	1	0	1	4	0	4.75	1.00
	105																						6a/5b-1	1	0	1	4	0	3.75	1.00
	106																						6a/6b-1	0	0	0	4	0	2.75	1.00
	107																						1a-2	0	1	1	7.33	3.33	3.75	1.00
	108																							0	0	0	7	-0.33	3.00	0.75
	109																							1	1	2	7	0	5.00	2.00
																							2a	0	0	0	7	0	3.00	2.00
	110																							1	1	2	7	0	5.00	2.00
																							2a/1a-2	1	0	1	7.33	0.33	3.63	1.38
	111																							1	0	1	7	-0.33	3.00	0.63
	112																						6a	0	0	0	6	-1	2.17	0.83
	113																						6a	1	0	1	5	-1	3.60	1.43
	114																						5b-1	1	0	1	6	1	3.67	0.07
	115																							1	0	1	6	0	3.67	0.00
	116																						5b-1/1a-2	1	0	1	7.33	1.33	2.75	0.92
	117																							1	0	1	6	-1.33	3.67	0.92
	118																						5b-1/1a-2	1	0	1	7.33	1.33	2.75	0.92
	119																						6a	1	0	1	6	-1.33	3.67	0.92
	120																							1	0	1	6	0	3.67	0.00
	121																							1	0	1	6	0	3.67	0.00
	122																							1	0	1	6	0	3.67	0.00
	123																							1	0	1	6	0	3.67	0.00
	124																							1	0	1	7	1	4.00	0.33
	125																						6a	0	0	0	4	-3	3.00	1.00
	126																						6a/6b-1	1	0	1	4	0	5.00	2.00
	127																						6a/6b-1	1	0	1	4	0	5.25	0.25
	128																						1a-2	2	1	3	7.33	3.33	5.50	0.25
	129																							1	1	2	7	-0.33	5.00	0.50
		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.89%	45.97%	67.14%	50.97%	71.77%	92.94%	94.16%	81.75%	39.40%	25.97%	#####	#####	2.92%	0.73%								

Praeludium in G Major (BuxWV 147)

Section	Bar No.	D*b*	A*b*	E*b*	B*b*	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (*Ab*, D#, A#)	Active External Pitches (*Gb*, *Db*, E#, B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1																				0	0	0	6	0	1.50	0.00
	2																				0	0	0	7	1	1.00	0.50
	3																			6a	0	0	0	5	-2	1.40	0.40
	4																				0	0	0	7	2	1.00	0.40
	5																			6a	0	0	0	3	-4	0.67	0.33
	6																			6a	0	0	0	5	2	1.60	0.93
	7																			6a	0	0	0	6	1	0.83	0.77
	8																				0	0	0	7	1	1.00	0.17
	9																			6a	0	0	0	6	-1	0.83	0.17
	10																				0	0	0	6	0	0.50	0.33
	11																				0	0	0	7	1	1.00	0.50
	12																			6a	0	0	0	5	-2	1.80	0.80
	13																			6a	0	0	0	3	-2	1.67	0.13
	14																				0	0	0	7	4	1.00	0.67
	15																				0	0	0	5	-2	1.00	0.00
	16																				0	0	0	6	1	1.50	0.50
	17																			6a	0	0	0	6	0	2.00	0.50
	18																			3a	0	0	0	7.66	1.66	1.50	0.50
	19																			1a-1	0	0	0	7.33	-0.33	1.50	0.00
	20																				0	0	0	7	-0.33	2.00	0.50
	21																				0	0	0	6	-1	0.50	1.50
	22																				0	0	0	7	1	1.00	0.50
	23																			1a-1	0	0	0	7.33	0.33	1.50	0.50
	24																			6a	0	0	0	3	-4.33	0.67	0.83
	25																			4	0	0	0	3	0	2.33	1.67
	26																			4	0	0	0	4	1	0.50	1.83
	27																			4	0	0	0	2	-2	2.50	2.00
	28																			6a	0	0	0	6	4	2.00	0.50
	29																				0	0	0	7	1	1.00	1.00
	30																			6a	0	0	0	6	-1	0.83	0.17
	31																				0	0	0	7	1	1.00	0.17
	32																				0	0	0	7	0	2.00	1.00
	33																				0	0	0	7	0	2.00	0.00
	34																				0	0	0	7	0	2.00	0.00
	35																				0	0	0	7	0	1.00	1.00
	36																			1a-1	0	0	0	7.33	0.33	1.50	0.50
	37																				0	0	0	7	-0.33	2.00	0.50
	38																				0	0	0	7	0	1.00	1.00
	39																			6a	0	0	0	5	-2	1.40	0.40
	40																				0	0	0	6	1	0.50	0.90
	41																			6a	0	0	0	5	-1	2.00	1.50
	42																			6a	0	0	0	6	1	2.00	0.00
	43																				0	0	0	7	1	1.00	1.00
	44																			6a	0	0	0	6	-1	0.83	0.17
	45																				0	0	0	7	1	1.00	0.17
	46																				0	0	0	7	0	2.00	1.00
	47																				0	0	0	7	0	2.00	0.00
	48																			6a	0	0	0	6	-1	1.83	0.17
	49																			6a	0	0	0	3	-3	2.00	0.17
	50																			6a	0	0	0	5	2	1.80	0.20
	51																				0	0	0	7	2	1.00	0.80
	52																				0	0	0	7	0	2.00	1.00
	53																				0	0	0	7	0	2.00	0.00
	54																			6a	0	0	0	6	-1	0.83	1.17
	55																			6a	0	0	0	5	-1	1.00	0.17
	56																				0	0	0	7	2	2.00	1.00

Praeludium in G Major (BuxWV 147)

Section	Bar No.	D*b*	A*b*	E*b*	B*b*	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (*Ab*, D#, A#)	Active External Pitches (*Gb*, *Db*, E#, B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	57																			1a-1	0	0	0	7.33	0.33	0.50	1.50
	58																				0	0	0	7	-0.33	1.00	0.50
	59																				0	0	0	6	-1	0.50	0.50
	60																				0	0	0	7	1	1.00	0.50
	61																				0	0	0	7	0	1.00	0.00
	62																				0	0	0	7	0	0.00	1.00
	63																				0	0	0	7	0	0.00	0.00
	64																				0	0	0	6	-1	-0.50	0.50
	65																				0	0	0	7	1	0.00	0.50
	66																				0	0	0	7	0	0.00	0.00
	67																			6a	0	0	0	6	-1	-0.17	0.17
	68																				0	0	0	7	1	1.00	1.17
	69																			1a-1	0	0	0	7.33	0.33	1.50	0.50
	70																			6a	0	0	0	3	-4.33	0.67	0.83
		0.00%	0.00%	0.00%	0.00%	10.00%	56.19%	95.71%	94.29%	85.71%	72.86%	91.43%	74.76%	29.50%	0.00%	0.00%	0.00%	0.00%	0.00%								

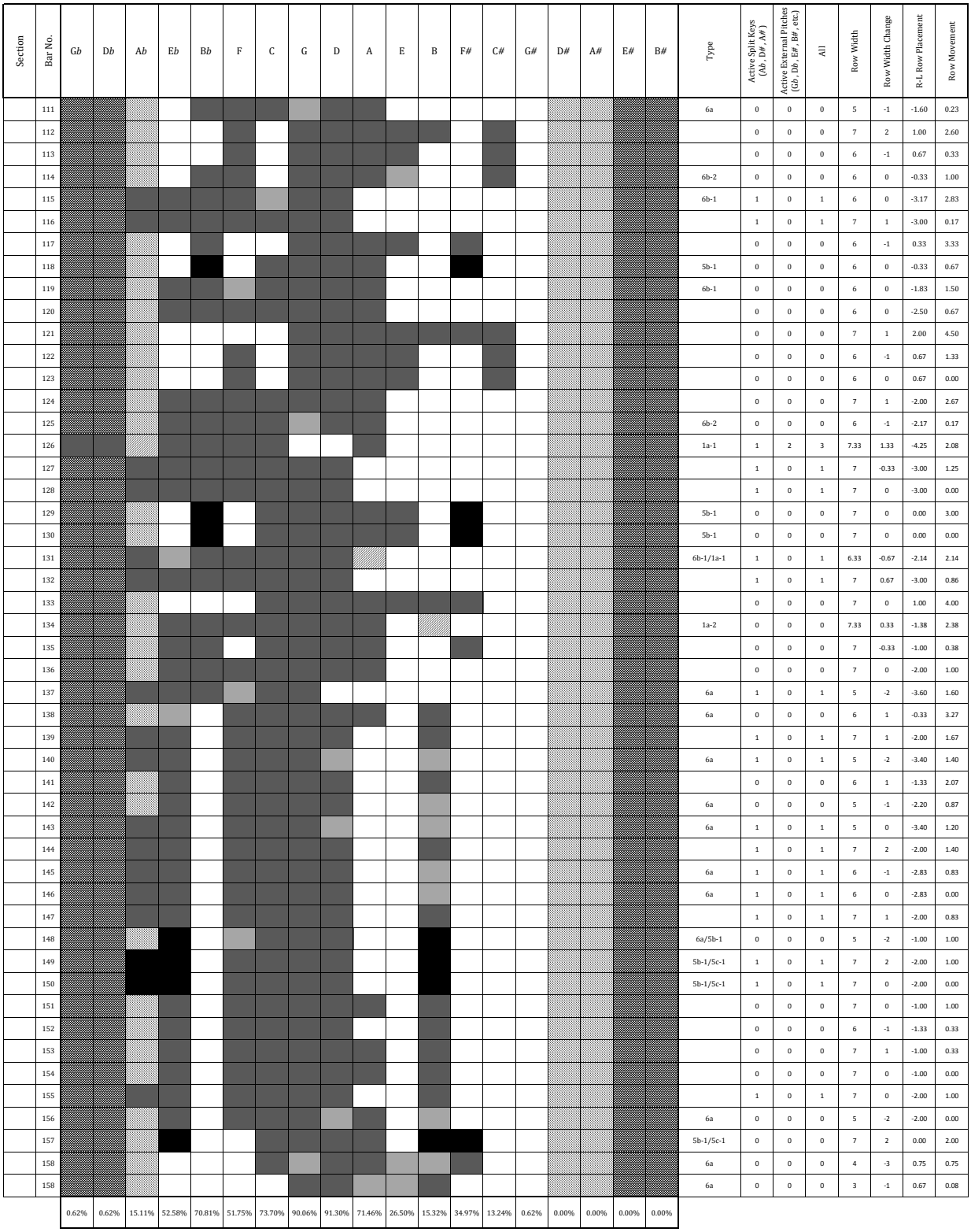
Praeludium in G Minor (BuxWV 149)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	1																				1a-2	0	0	0	7.33	0	0.63	0.00
	2																				6b-1	0	0	0	6	-1.33	-1.83	2.46
	3																				6b-1	0	0	0	6	0	-1.83	0.00
	4																				6a	0	0	0	6	0	-2.17	0.33
	5																				6a	0	0	0	6	0	-2.17	0.00
	6																					0	0	0	6	0	-0.33	1.83
	7																				6a	0	0	0	5	-1	-1.20	0.87
	8																					0	0	0	7	2	-1.00	0.20
	9																				6a	0	0	0	4	-3	-1.50	0.50
	10																					0	0	0	7	3	-1.00	0.50
	11																				6a	0	0	0	6	-1	-1.83	0.83
	12																					0	0	0	7	1	-1.00	0.83
	13																					0	0	0	7	0	-2.00	1.00
	14																				1a-2	0	0	0	7.33	0.33	-1.25	0.75
																					2a	0	0	0	7	-0.33	0.00	1.25
	15																					0	0	0	7	0	-1.00	1.00
	16																				5c-1	0	0	0	7	0	-1.00	0.00
	17																				5b-1/5c-1	0	0	0	7	0	-1.00	0.00
	18																				5b-1/5c-1/1a-2	0	0	0	7.33	0.33	-1.25	0.25
	19																				6b-2	0	0	0	6	-1.33	-1.83	0.58
	20																					0	0	0	1	-5	-1.00	0.83
Fuga	21																				4	0	0	0	3	2	-2.00	1.00
	22																				4	0	0	0	3	0	-0.33	1.67
	23																				4	0	0	0	4	1	0.00	0.33
	24																				6b-1	0	0	0	6	2	-1.83	1.83
	25																				6b-1	0	0	0	6	0	-0.67	1.17
	26																					0	0	0	7	1	0.00	0.67
	27																				3a	0	0	0	7.66	0.66	-0.38	0.38
	28																				6a	0	0	0	6	-1.66	-2.00	1.63
																					6a/2a/1a-2	0	0	0	6.33	0.33	-0.14	1.86
	29																					0	0	0	6	-0.33	-0.33	0.19
	30																					0	0	0	7	1	-2.00	1.67
	31																				6c	0	0	0	5	-2	0.00	2.00
	32																					0	0	0	7	2	0.00	0.00
	33																					0	0	0	7	0	0.00	0.00
	34																				6a/5b-1/3a	0	0	0	5.66	-1.34	-0.83	0.83
	35																				6a/1a-2	0	0	0	6.33	0.67	-1.29	0.45
	36																				1a-1	0	0	0	7.33	1	-0.25	1.04
	37																					0	0	0	7	-0.33	-1.00	0.75
	38																					0	0	0	6	-1	-0.33	0.67
	39																				6a	0	0	0	6	0	-1.83	1.50
	40																				1a-2	0	0	0	7.33	1.33	-0.38	1.46
	41																				1a-2	0	0	0	7.33	0	-1.25	0.88
	42																					0	0	0	6	-1.33	-0.33	0.92
	43																				6b-1	0	0	0	6	0	-0.67	0.33
	44																				1a-1	0	0	0	7.33	1.33	-0.25	0.42
	45																				3a/1a-2	0	0	0	6.99	-0.34	0.75	1.00
	46																				1a-2	0	0	0	7.33	0.34	-1.25	2.00
	47																				5b-1/1a-2	0	0	0	7.33	0	-0.63	0.63
	48																					0	0	0	6	-1.33	-0.33	0.29
	49																				5b-1	0	0	0	7	1	-1.00	0.67
	50																					1	0	1	7	0	-1.00	0.00
	51																				6a/3a	0	0	0	5.66	-1.34	0.33	1.33
	52																				3a	0	0	0	7.66	2	1.38	1.04
	53																				6a	0	0	0	5	-2.66	0.00	1.38
	54																					0	0	0	7	2	1.00	1.00

Praeludium in G Minor (BuxWV 149)

Section	Bar No.	G♭	D♭	A♭	E♭	B♭	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
Allegro	55																					0	0	0	6	-1	-0.33	1.33
	56																				1a-2	0	0	0	8.33	2.33	-0.89	0.56
	57																					0	0	0	7	-1.33	-1.00	0.11
	58																				6a/1a-1	0	0	0	6.33	-0.67	-1.14	0.14
	59																				6a	0	0	0	5	-1.33	-1.60	0.46
	60																				6a	0	0	0	4	-1	-2.00	0.40
	61																					1	0	1	6	2	-3.50	1.50
	62																					1	0	1	7	1	-3.00	0.50
	63																					1	0	1	7	0	-2.00	1.00
	64																				6a/1a-2	1	0	1	6.33	-0.67	-2.43	0.43
	65																					1	0	1	6	-0.33	-3.50	1.07
	66																					1	0	1	7	1	-3.00	0.50
	67																					0	0	0	7	0	-1.00	2.00
	68																				6a/5b-1	0	0	0	5	-2	0.00	1.00
	69																				6a/5b-1	0	0	0	5	0	-0.60	0.60
	70																				6a/5b-1	0	0	0	5	0	-1.20	0.60
	71																				6a/5b-1	0	0	0	5	0	-0.60	0.60
	72																					0	0	0	7	2	-1.00	0.40
	73																				6a/5b-1	0	0	0	3	-4	-0.33	0.67
	74																				6a/5c-1	0	0	0	6	3	-1.33	1.00
	75																				6a/5b-1	0	0	0	6	0	-1.33	0.00
	76																				6a/5c-1	0	0	0	6	0	-1.33	0.00
	77																				6a/5b-1	0	0	0	6	0	-0.83	0.50
Largo	78																				4	0	0	0	3	-3	-1.67	0.83
	79																				4	0	0	0	2	-1	-4.50	2.83
	80																				4	0	0	0	2	0	0.50	5.00
	81																				4	0	0	0	4	2	1.00	0.50
	82																				6b-1	0	0	0	5	1	-2.40	3.40
	83																				6b-2	0	0	0	5	0	-2.80	0.40
	84																				6a	0	0	0	5	0	2.20	5.00
	85																				6a/6b-1	0	0	0	4	-1	1.00	1.20
	86																				6b-1	0	0	0	5	1	-1.40	2.40
	87																					0	0	0	6	1	-2.50	1.10
	88																					0	0	0	7	1	0.00	2.50
	89																					0	0	0	6	-1	-0.33	0.33
	90																					0	0	0	7	1	-2.00	1.67
	91																					0	0	0	7	0	-2.00	0.00
	92																					0	0	0	7	0	1.00	3.00
	93																					0	0	0	6	-1	0.67	0.33
	94																					0	0	0	7	1	0.00	0.67
	95																					0	0	0	7	0	0.00	0.00
	96																				6a	0	0	0	5	-2	1.20	1.20
	97																				6b-1	0	0	0	5	0	-2.40	3.60
	98																				6a	0	0	0	6	1	-2.17	0.23
	99																				6a/5b-1	0	0	0	5	-1	0.00	2.17
	100																				6a	0	0	0	5	0	0.00	0.00
	101																					0	0	0	6	1	-0.33	0.33
	102																				6b-1	0	0	0	6	0	-1.83	1.50
	103																					0	0	0	7	1	-2.00	0.17
	104																					0	0	0	7	0	1.00	3.00
	105																					0	0	0	6	-1	0.67	0.33
	106																				6b-1	0	0	0	6	0	-0.83	1.50
	107																					0	0	0	7	1	-2.00	1.17
	108																				5b-1	0	0	0	7	0	0.00	2.00
	109																				5b-1	0	0	0	6	-1	-0.33	0.33
	110																				6b-1	0	0	0	6	0	-1.83	1.50

Praeludium in G Minor (BuxWV 149)



Section	Bar No.	Type	Active Split Keys (Ab , D# , A#)	Active External Pitches (Gb , Db , E# , B# etc.)	All	Row Width	Row Width Change	R-L Row Placement	Row Movement
	111	6a	0	0	0	5	-1	-1.60	0.23
	112		0	0	0	7	2	1.00	2.60
	113		0	0	0	6	-1	0.67	0.33
	114	6b-2	0	0	0	6	0	-0.33	1.00
	115	6b-1	1	0	1	6	0	-3.17	2.83
	116		1	0	1	7	1	-3.00	0.17
	117		0	0	0	6	-1	0.33	3.33
	118	5b-1	0	0	0	6	0	-0.33	0.67
	119	6b-1	0	0	0	6	0	-1.83	1.50
	120		0	0	0	6	0	-2.50	0.67
	121		0	0	0	7	1	2.00	4.50
	122		0	0	0	6	-1	0.67	1.33
	123		0	0	0	6	0	0.67	0.00
	124		0	0	0	7	1	-2.00	2.67
	125	6b-2	0	0	0	6	-1	-2.17	0.17
	126	1a-1	1	2	3	7.33	1.33	-4.25	2.08
	127		1	0	1	7	-0.33	-3.00	1.25
	128		1	0	1	7	0	-3.00	0.00
	129	5b-1	0	0	0	7	0	0.00	3.00
	130	5b-1	0	0	0	7	0	0.00	0.00
	131	6b-1/1a-1	1	0	1	6.33	-0.67	-2.14	2.14
	132		1	0	1	7	0.67	-3.00	0.86
	133		0	0	0	7	0	1.00	4.00
	134	1a-2	0	0	0	7.33	0.33	-1.38	2.38
	135		0	0	0	7	-0.33	-1.00	0.38
	136		0	0	0	7	0	-2.00	1.00
	137	6a	1	0	1	5	-2	-3.60	1.60
	138	6a	0	0	0	6	1	-0.33	3.27
	139		1	0	1	7	1	-2.00	1.67
	140	6a	1	0	1	5	-2	-3.40	1.40
	141		0	0	0	6	1	-1.33	2.07
	142	6a	0	0	0	5	-1	-2.20	0.87
	143	6a	1	0	1	5	0	-3.40	1.20
	144		1	0	1	7	2	-2.00	1.40
	145	6a	1	0	1	6	-1	-2.83	0.83
	146	6a	1	0	1	6	0	-2.83	0.00
	147		1	0	1	7	1	-2.00	0.83
	148	6a/5b-1	0	0	0	5	-2	-1.00	1.00
	149	5b-1/5c-1	1	0	1	7	2	-2.00	1.00
	150	5b-1/5c-1	1	0	1	7	0	-2.00	0.00
	151		0	0	0	7	0	-1.00	1.00
	152		0	0	0	6	-1	-1.33	0.33
	153		0	0	0	7	1	-1.00	0.33
	154		0	0	0	7	0	-1.00	0.00
	155		1	0	1	7	0	-2.00	1.00
	156	6a	0	0	0	5	-2	-2.00	0.00
	157	5b-1/5c-1	0	0	0	7	2	0.00	2.00
	158	6a	0	0	0	4	-3	0.75	0.75
	158	6a	0	0	0	3	-1	0.67	0.08

Gb	Db	Ab	Eb	Bb	F	C	G	D	A	E	B	F#	C#	G#	D#	A#	E#	B#
0.62%	0.62%	15.11%	52.58%	70.81%	51.75%	73.70%	90.06%	91.30%	71.46%	26.50%	15.32%	34.97%	13.24%	0.62%	0.00%	0.00%	0.00%	0.00%

Appendix 2: Numerical Data

C Major	BuxWV 136	Numbe of Active Cells:	1	0	1	Average Row Width:	7.030891	Average Row Width Change:	0.479802	Average Center:	0.36372
		Number of Active Units:	1	0	1	High Value:	7.66	High Growth:	3.66	Average Row Movement:	0.62994
		Percentage of Units:	0.99%	0.00%	0.99%	Low Value:	4	High Shrink:	-3.33		
C Major	BuxWV 137	Numbe of Active Cells:	3	0	3	Average Row Width:	6.516381	Average Row Width Change:	0.830381	Average Center:	0.28258
		Number of Active Units:	3	0	3	High Value:	8.98	High Growth:	3	Average Row Movement:	0.63825
		Percentage of Units:	2.86%	0.00%	2.86%	Low Value:	3	High Shrink:	-4		
C Major	BuxWV 138	Numbe of Active Cells:	0	0	0	Average Row Width:	6.778451	Average Row Width Change:	0.482535	Average Center:	0.07864
		Number of Active Units:	0	0	0	High Value:	7.66	High Growth:	2	Average Row Movement:	0.52767
		Percentage of Units:	0.00%	0.00%	0.00%	Low Value:	5	High Shrink:	-2.33		
D Major	BuxWV 139	Numbe of Active Cells:	10	7	17	Average Row Width:	6.360182	Average Row Width Change:	0.744727	Average Center:	2.39114
		Number of Active Units:	10	7	13	High Value:	7.99	High Growth:	4	Average Row Movement:	0.65076
		Percentage of Units:	9.09%	6.36%	11.82%	Low Value:	2	High Shrink:	-5.33		
D Minor	BuxWV 140	Numbe of Active Cells:	3	0	3	Average Row Width:	6.276885	Average Row Width Change:	0.82918	Average Center:	-0.40149
		Number of Active Units	3	0	3	High Value:	8.32	High Growth:	3.66	Average Row Movement:	0.85386
		Percentage of Units:	2.46%	0.00%	2.46%	Low Value:	3	High Shrink:	-4.33		
E Major	BuxWV 141	Numbe of Active Cells:	139	20	159	Average Row Width:	6.671111	Average Row Width Change:	0.765385	Average Center:	4.30332
		Number of Active Units:	106	18	106	High Value:	7.66	High Growth:	4	Average Row Movement:	0.59904
		Percentage of Units:	90.6%	15.4%	90.60%	Low Value:	3	High Shrink:	-4.33		
E Minor	BuxWV 142	Numbe of Active Cells:	140	6	146	Average Row Width:	6.975954	Average Row Width Change:	1.057746	Average Center:	2.44279
		Number of Active Units:	114	6	115	High Value:	8.98	High Growth:	4.32	Average Row Movement:	1.0595
		Percentage of Units:	65.90%	3.47%	66.5%	Low Value:	3	High Shrink:	-5.32		

F Major	BuxWV 145	Numbe of Active Cells:	5	0	5	Average Row Width:	6.268217	Average Row Width Change:	0.645271	Average Center:	-0.96477
		Number of Active Units:	5	0	5	High Value:	7.66	High Growth:	3	Average Row Movement:	0.54395
		Percentage of Units:	3.88%	0.00%	3.88%	Low Value:	2	High Shrink:	-3		
F-Sharp Minor	BuxWV 146	Numbe of Active Cells:	95	79	174	Average Row Width:	6.278832	Average Row Width Change:	0.843212	Average Center:	4.32371
		Number of Active Units:	80	70	102	High Value:	8.32	High Growth:	4	Average Row Movement:	0.9884
		Percentage of Units:	58.39%	51.09%	74.45%	Low Value:	3	High Shrink:	-4.33		
G Major	BuxWV 147	Numbe of Active Cells:	0	0	0	Average Row Width:	6.104429	Average Row Width Change:	1.099429	Average Center:	1.20476
		Number of Active Units:	0	0	0	High Value:	7.66	High Growth:	4	Average Row Movement:	0.57476
		Percentage of Units:	0.00%	0.00%	0.00%	Low Value:	2	High Shrink:	-4.33		
G Minor	BuxWV 149	Numbe of Active Cells:	25	2	27	Average Row Width:	6.082236	Average Row Width Change:	0.871366	Average Center:	-1.06024
		Number of Active Units:	25	1	25	High Value:	8.33	High Growth:	3	Average Row Movement:	1.08236
		Percentage of Units:	15.53%	0.62%	15.53%	Low Value:	1	High Shrink:	-5		

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Arranged by Percentage of Split Key Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	9.09%
G Minor	BuxWV 149	15.53%
F-Sharp Minor	BuxWV 146	58.39%
E Minor	BuxWV 142	65.90%
E Major	BuxWV 141	90.60%

Arragned by Percentage of External Pitch Temporal Units:

C Major	BuxWV 136	0.00%
C Major	BuxWV 137	0.00%
C Major	BuxWV 138	0.00%
D Minor	BuxWV 140	0.00%
F Major	BuxWV 145	0.00%
G Major	BuxWV 147	0.00%
G Minor	BuxWV 149	0.62%
E Minor	BuxWV 142	3.47%
D Major	BuxWV 139	6.36%
E Major	BuxWV 141	15.38%
F-Sharp Minor	BuxWV 146	51.09%

Arranged by Percentage of All Problematic Temporal Units:

C Major	BuxWV 138	0.00%
G Major	BuxWV 147	0.00%
C Major	BuxWV 136	0.99%
D Minor	BuxWV 140	2.46%
C Major	BuxWV 137	2.86%
F Major	BuxWV 145	3.88%
D Major	BuxWV 139	11.82%
G Minor	BuxWV 149	15.53%
E Minor	BuxWV 142	66.47%
F-Sharp Minor	BuxWV 146	74.45%
E Major	BuxWV 141	90.60%

Arranged by Average Row Width:

G Minor	BuxWV 149	6.082236025
G Major	BuxWV 147	6.104428571
F Major	BuxWV 145	6.268217054
D Minor	BuxWV 140	6.276885246
F-Sharp Minor	BuxWV 146	6.278832117
D Major	BuxWV 139	6.360181818
C Major	BuxWV 137	6.516380952
E Major	BuxWV 141	6.671111111
C Major	BuxWV 138	6.778450704
E Minor	BuxWV 142	6.975953757
C Major	BuxWV 136	7.030891089

Arranged by Highest Value Row Width:

C Major	BuxWV 136	7.66
C Major	BuxWV 138	7.66
E Major	BuxWV 141	7.66
F Major	BuxWV 145	7.66
G Major	BuxWV 147	7.66
D Major	BuxWV 139	7.99
D Minor	BuxWV 140	8.32
F-Sharp Minor	BuxWV 146	8.32
G Minor	BuxWV 149	8.33
C Major	BuxWV 137	8.98
E Minor	BuxWV 142	8.98

Arranged by Average Row Width Change:

C Major	BuxWV 136	0.47980198
C Major	BuxWV 138	0.482535211
F Major	BuxWV 145	0.645271318
D Major	BuxWV 139	0.744727273
E Major	BuxWV 141	0.765384615
D Minor	BuxWV 140	0.829180328
C Major	BuxWV 137	0.830380952
F-Sharp Minor	BuxWV 146	0.843211679
G Minor	BuxWV 149	0.87136646
E Minor	BuxWV 142	1.057745665
G Major	BuxWV 147	1.099428571

Arranged by Average Row Movement:

C Major	BuxWV 138	0.527665996
F Major	BuxWV 145	0.543946106
G Major	BuxWV 147	0.574761905
E Major	BuxWV 141	0.599043549
C Major	BuxWV 136	0.629938708
C Major	BuxWV 137	0.638253968
D Major	BuxWV 139	0.650757576
D Minor	BuxWV 140	0.853864169
F-Sharp Minor	BuxWV 146	0.988396478
E Minor	BuxWV 142	1.059503165
G Minor	BuxWV 149	1.082364685

Appendix 3: Explanations of Graphing Subtleties

It would be futile to expect to capture all subtleties of harmonic and melodic language in such a restrictive graphing system. It would be equally futile to expect the developed, even prototypal, system to be used without hitch. If one looked at single individual pieces and graphed them without consideration of other pieces, this system, even the layout of the graphs themselves, would be more definitive. When one looks at a wide range of pieces—keys, styles, etc.—one will find the system need be generalized as has been done here. Individual pieces, then, may seem to be done an injustice as certain "types" are assigned to each measure, shielding some musical feature from view. Though many features may be lost, this "type" assignment to musical subtleties hopes to unify a rather wide range of material. Though the system will probably continue to function for music that is considerably more complex (i.e., music of the nineteenth and twentieth centuries), it will likely be taxed to the point of uselessness. If other music were to be analyzed, the system ought to be refined and expanded. In the following section, each measure "type" will be explored, exposing the underlying thought in an attempt to make such results, both numerical and visual, reproducible—in other words, to keep an exploratory document as empirical as possible. Musical examples will be provided for clarity, but graphs in Appendix 1 should be consulted simultaneously.

Figure 6: Type Coding Subtleties

1a-1	Directionality has more weight than temporality – in avoidance of a measure split unrelated to melodic minor.	Diagonal Shade
1a-2	Directionality has more weight than temporality – in avoidance of a measure split related to melodic minor	Diagonal Shade
1b	Double leading-tone cadence	Diagonal Shade
1c-1	Directionality weighs less than temporality – no melodic minor	Diagonal Shade
1c-2	Directionality weighs less than temporality – melodic minor	Diagonal Shade
1d	2 diagonally shaded cells to accommodate melodic minor without a split	Diagonal Shade
2a	Split measure to accommodate melodic minor	Measure Split
2b	Extenuating shifting metrical issue	Measure Split
3a	Regular augmented unison	Horizontal Hash
3b	Augmented unison trumps some other feature	Horizontal Hash
3c	Quasi-augmented unison	Diagonal Shade
4	Exclusion of pitch for rhetorical gesture	Dotted Shade
5a-1	7 Fifths (1 too far) minor infraction (incomplete neighbor, passing, short duration etc.)	Black Cell
5a-2	7 Fifths (1 too far) major infraction (sustained)	Black Row
5b-1	8 Fifths (2 too far) minor infraction	Black Cell
5b-2	8 Fifths (2 too far) major infraction	Black Row
5c-1	9 Fifths (3 too far) minor infraction	Black Cell
5c-2	9 Fifths (3 too far) major infraction	Black Row
5d-1	10 Fifths (4 too far) minor infraction	Black Cell
5d-2	10 Fifths (4 too far) major infraction	Black Row
6a	Fill 2 cells for measures containing single chords *or* Fill with context in previous and following measures	Light-Grey Cell
6b-1	Fill with context in following measure only	Light-Grey Cell
6b-2	Fill with context in previous measure only	Light-Grey Cell
6c	No fill for intentional pivoting gesture (regardless of acceptable patterning)	Nothing
6d	Filling without context at all (To accommodate acceptable patterning)	Light-Grey Cell
*	Outright exclusion of pitch material	*

1, General

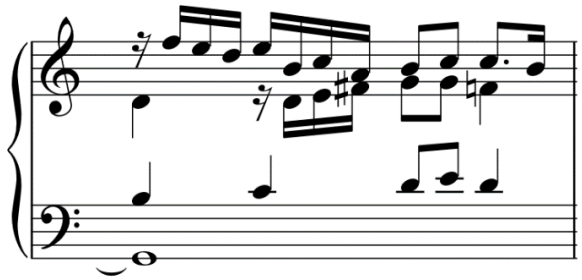
When a temporal unit as secure, unmovable, and finite as a measure is chosen, the immediate problem occurs that measures often contain two different pitches of the same note name (i.e. F and F sharp). More often than not, these pitches do not occur in succession or at the same time. Usually there is a buffer. These pitches generally go unnoticed in regard to tuning, though exceptions certainly do manifest themselves. When one's goal is to analyze a piece of music within the context of a tuning system, it would be the highest necessity to restrict the analysis to the six fifths (or seven notes) of a saturated diatonic heptachord. Pitches occurring outside of this heptachord are likely accounted for under the "type 1" heading. Pitches occurring outside of the heptachord that are in succession with a pitch of the same note name (augmented unison intervals) will be treated in "type 3." Pitches that occur simultaneously with another pitch more than six fifths away will be assigned a specific "type 1," if necessary, while also being given a "type 5" coding. This specific case might better be expounded upon after a thorough explanation of sub-categories is given. All "type 1" measures will contain a diagonally shaded cell when graphed.

1a-1 and 1a-2

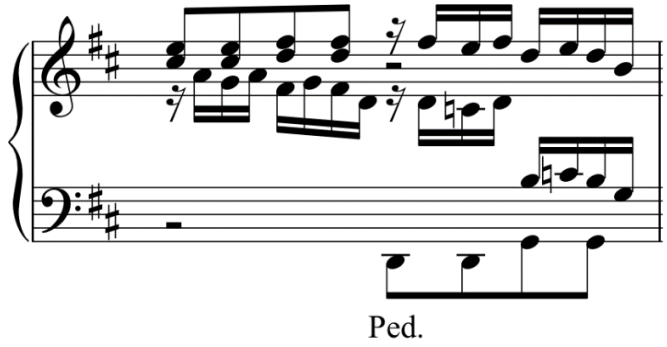
All "type 1a" measures contain only one pitch outside of a saturated heptachord. As an analyst, one must decide which tone of the same note name is more central. When coding a measure "type 1a" the decision has been made to emphasize the pitch that occurs in the latter part of the measure, therefore diagonally shading the pitch that occurs earlier in the measure. This very simple distinction is juxtaposed with "type 1c" which emphasizes the pitch earlier in the measure. 1a-1 and 1a-2 are distinguished by the reason this pitch exists. 1a-1 will account for pitches that are not related to harmonic or melodic minor, while 1a-2 deals with altered pitch

material that is related to the occurrence of harmonic or melodic minor. 1a-1 could be a secondary dominant, a brief tonicization, or something similar. This distinction is not always firm or clear and sometimes altered pitches do not have clear purposes. To create some sense of standardization between 1a and 1c types, it is necessary to favor one over the other in ambiguous measures. When in doubt of hierarchical importance, 1a-1 and 1a-2 will always be favored over "type 1c."

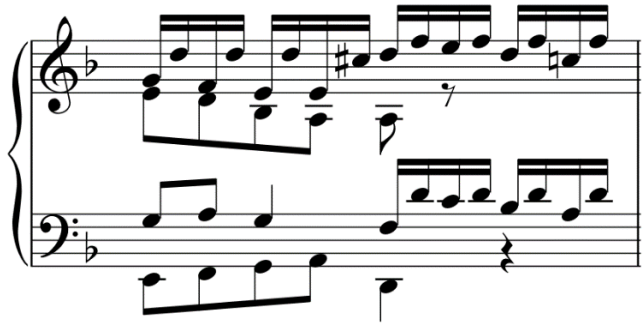
Example 12: BuxWV 136, m. 12, ex. "type 1a-1"



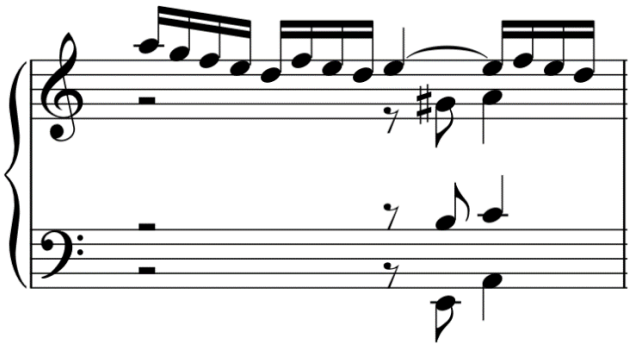
Example 13: BuxWV 139, m. 79, ex. "type 1a-1"



Example 14: BuxWV 140, m. 9, ex. "type 1a-2"



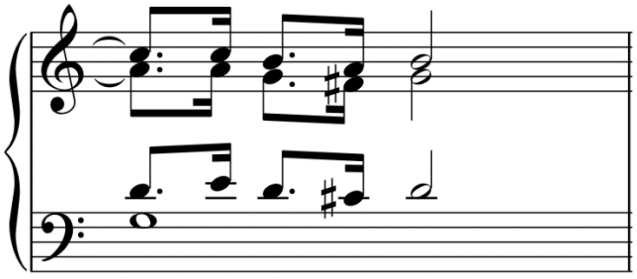
Example 15: BuxWV 137, m. 26, ex. “type 1a-2”



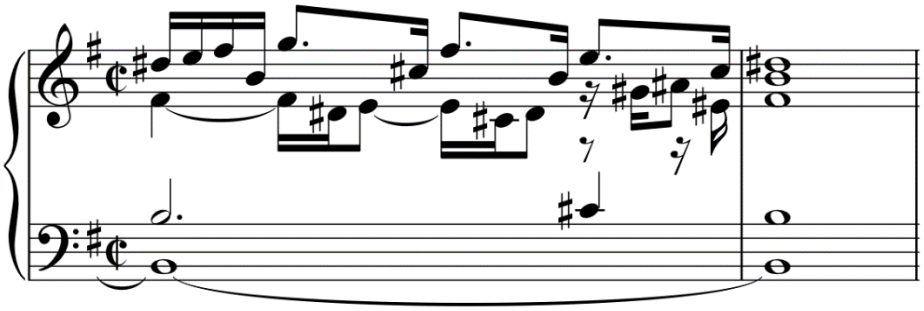
1b

“Type 1b” measures are simply identified as containers of double-leading-tone cadences. A double-leading-tone cadence, here, is defined as a cadence where the concluding triad is approached by the leading tone and a chromatically raised pitch leading to the fifth of the triad.

Example 16: BuxWV 136, m. 47, ex. “type 1b”



Example 17: BuxWV 142, mm. 99 and 100, ex. “type 1b”

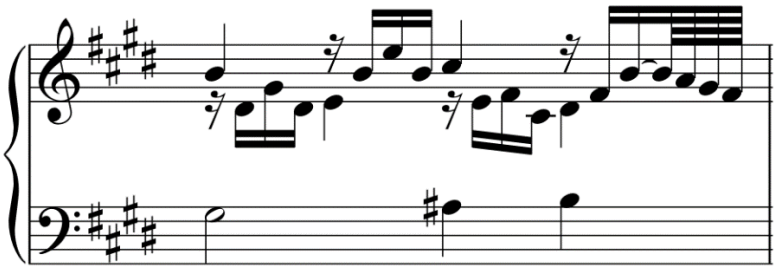


1c-1 and 1c-2

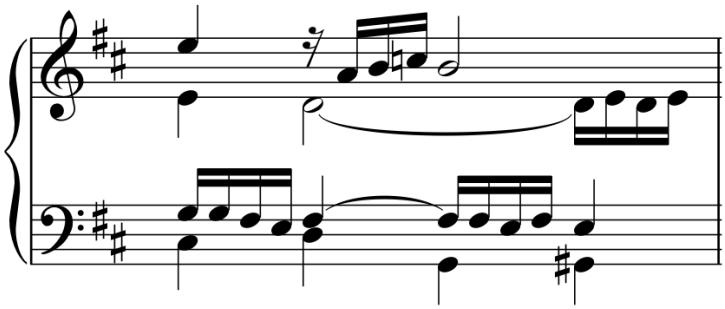
The rules and considerations for “type 1c” measures are parallel with those of “type 1a.” This time, one chooses to analyze the pitch that occurs earlier in the measure. Therefore, the

pitch that occurs later in the measure is diagonally shaded and the earlier pitch receives a higher hierarchical status. “Type 1a” measures are always favored whenever possible, but “type 1c” may be used in extenuating circumstances. These circumstances could include, but are not limited to, an internal cadence, a shifting metrical issue, insignificant weight applied to the latter pitch, an issue related to a measure split (“type 2”), or an issue related to implied pitches in surrounding measures (“type 6”). Again, “type 1c-1” indicates a tone not related to harmonic or melodic minor while a “type 1c-2” coding indicates a pitch that exists for melodic or harmonic minor reasons.

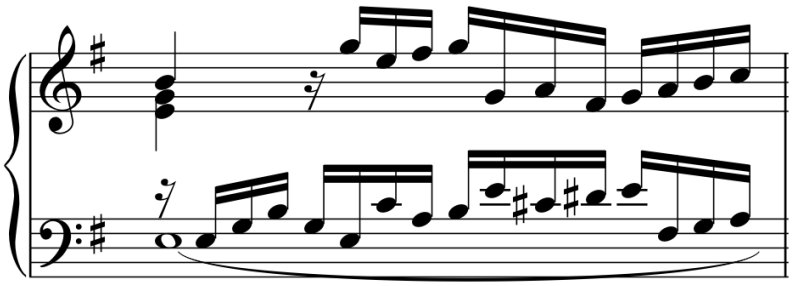
Example 18: BuxWV 141, m. 68, ex. “type 1c-1”



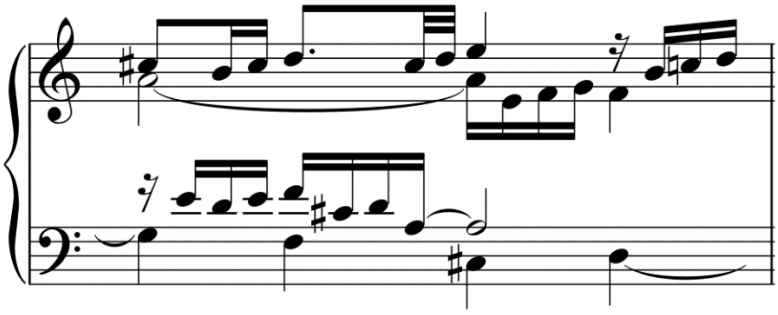
Example 19: BuxWV 139, m. 19, ex. “type 1c-1”



Example 20: BuxWV 142, m. 2, ex. “type 1c-2”



Example 21: BuxWV 136, m. 6, ex. “type 1c-2”

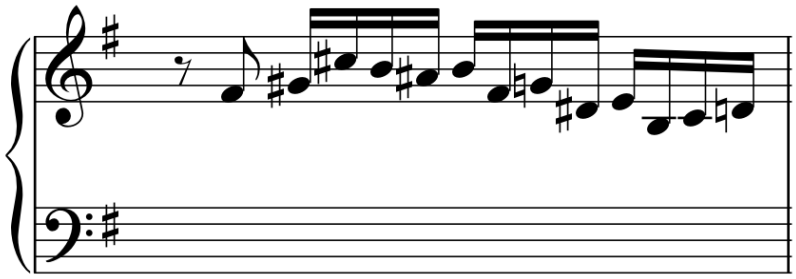


1d

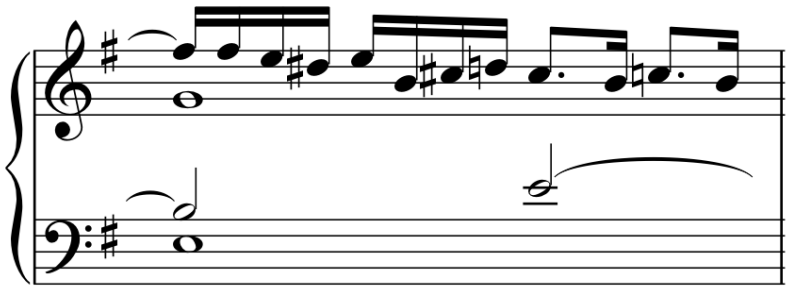
“Type 1d” measures, rare occurrences that can usually be handled in some other fashion, contain two chromatically altered pitches and two diagonally shaded cells. “Type 1d” measures exist almost always because of a particularly active melodic passage in minor (containing altered sixth and seventh scale degrees in quick succession). Usually, “type 1d” measures can be avoided through a measure split (“type 2”). Sometimes melodic minor can be finicky, and sometimes there is not enough information in either half of the measure to split it. However, even if the latter is the case, one can often be creative with a usage of “type 6” shading to achieve clarity in a measure split. So, “type 1d” measures should be used sparingly as to avoid inconsistent graphing and skewed data. In the event that this coding must be used, the decision still needs to be made which two notes ought to be emphasized and which two notes ought to be

graphed with diagonal shading. Due to ambiguity and infrequency of these measures, no more specific distinctions have been made.

Example 22: BuxWV 142, m. 101, ex. "type 1d"



Example 23: BuxWV 142, m. 110, ex. "type 1d"



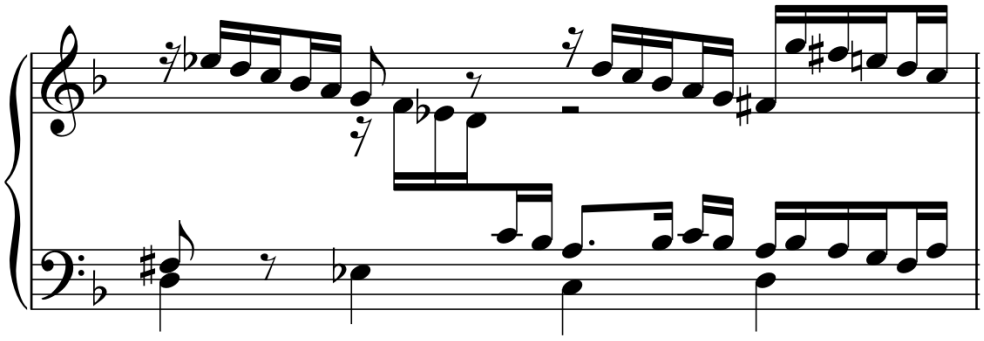
2, General

"2 Type" measures are the only type that is not reflected in the graph by some kind of shading or indication. Instead, this type is executed using a measure split. Due to a saturation of pitch material from two or more chromatically altered pitches, the measure is split into two temporal units, equal in size, unless otherwise indicated (if the section is in triple meter). Doing so often results in inadequate pitch material. "Type 6" should be readily employed to make up for such problems. These measures should be used sparingly since numerical data is affected.

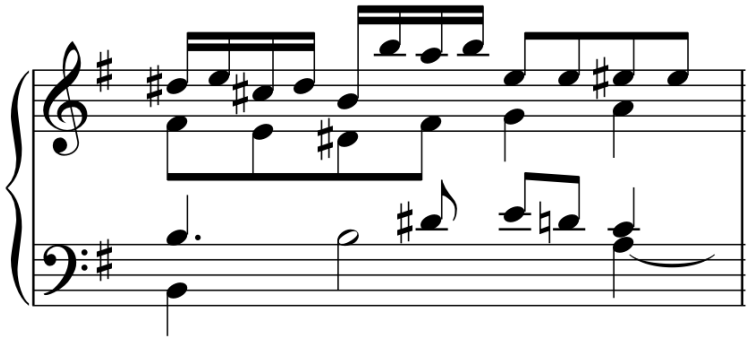
2a

This measure split occurs due to a usage of melodic minor. It is usually straightforward, but "type 1d" may need to be utilized for measures that still would contain two diagonally shaded cells.

Example 24: BuxWV 149, m. 14, ex. “type 2a”



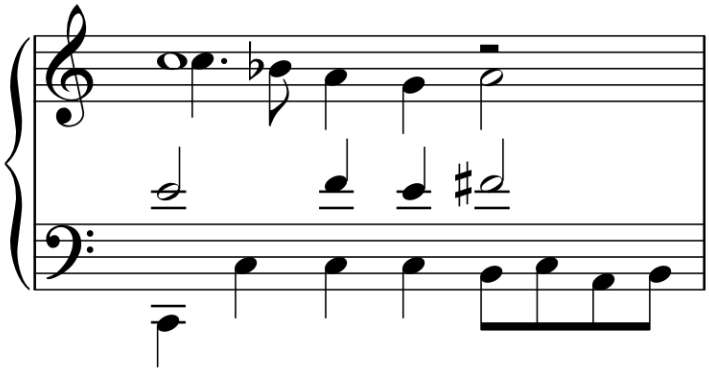
Example 25: BuxWV 142, m. 31, ex. “type 2a”



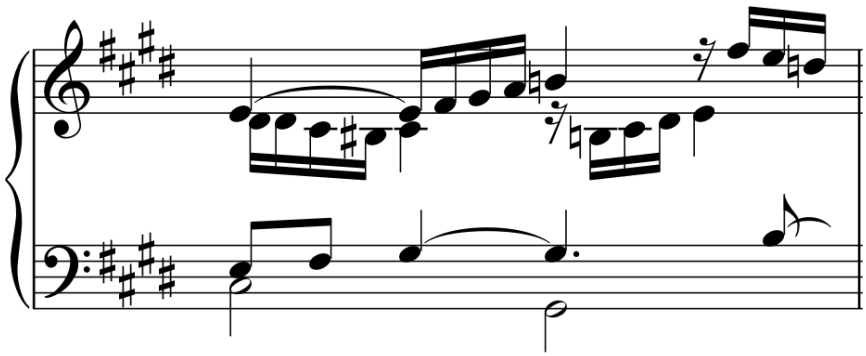
2b

Though less common than “type 2a,” “type 2b” occurs with some frequency. This measure split attempts to compensate for shifting metrical issues or quick harmonic motion through key areas. It is likely that these half measures could have stood on their own if the composer had given them more space to exist, so “type 6” will need to be utilized in conjunction less often than with “type 2a.”

Example 26: BuxWV 137, m. 81, ex. “type 2b”



Example 27: BuxWV 141, m. 9, ex. “type 2b”

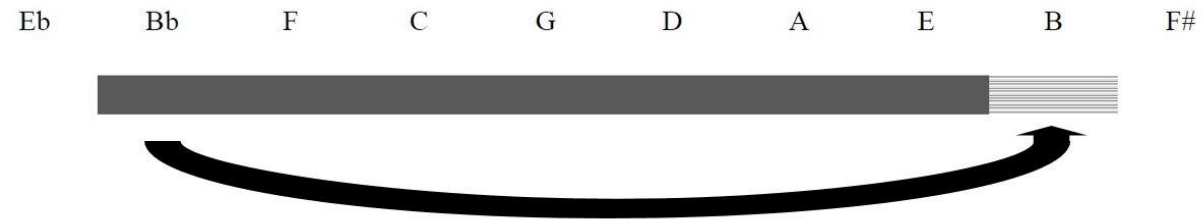


3, General

“Type 3” measures are characterized by their horizontally hashed cells. This classification accounts for all augmented unison intervals. If two pitches occur in succession a half-step apart and are of the same note name (i.e. F to F sharp, not F to G flat), they must be accounted for with this coding. This succession must be treated differently than “type 1” since they are used differently in composition and create audible tuning issues. The origins of these issues remain to be seen and are not central to this document. However, two possible hypotheses may be asserted: (1) augmented unisons sound melodically dissonant because they could really be coded “type 5a,” which is essentially a cross-relation. This could be in-part due to the acoustic of the room and the holdover of the first pitch. The distance traversed harmonically covers one fifth more than is acceptable in a diatonic pitch collection (see Figure 7). (2) Our ears or brains

are accustomed to two equally sized semitones in equal temperament, and in meantone, the semitones are not equally sized. In this case, the hypothesis implies that these intervals are dissonant to the modern ear only, and not to a seventeenth century ear.

Figure 7: "Type 3" Demonstration



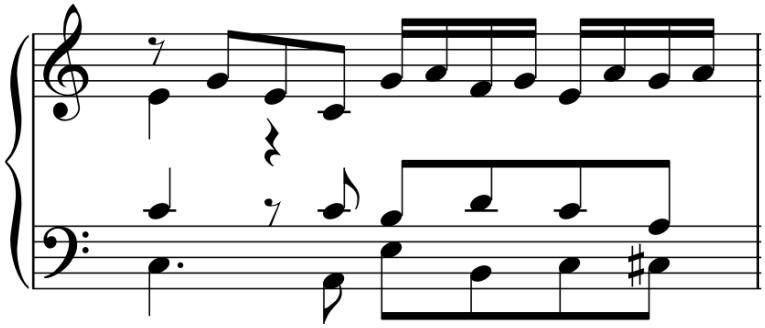
Though it is often debatable which of the two pitches achieves a higher hierarchical status, the first pitch is always given preference. This decision was made arbitrarily, with the consideration that the second pitch seems to sound more dissonant, regardless of harmonic support.[79] If multiple occurrences occur in one measure the measure need not be split, but rather the occurrences can all be included in the same unit.

3a and 3b

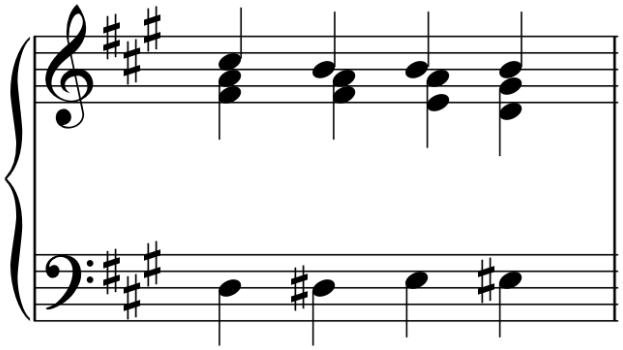
So far, there seems little reason to distinguish between different contexts and harmonic support situations in the graphing process. Therefore, "type 3a" can account for almost all occurrences of augmented unisons. The only exception is when a "type 3" occurs in the same measure, on the same pitch as a "type 1." This occurrence can be accounted for by "type 3b."

[79] This notation and coding could change if it were possible to prove one of the above hypotheses over the other.

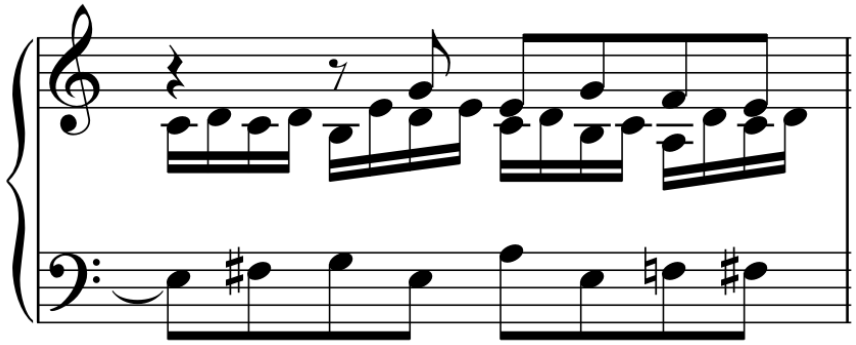
Example 28: BuxWV 138, m. 44, ex. “type 3a”



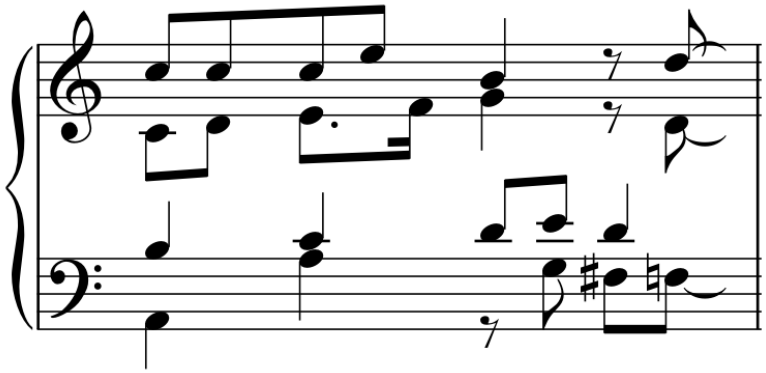
Example 29: BuxWV 146, m. 16, ex. “type 3a”



Example 30: BuxWV 138, m. 47, ex. “type 3b”



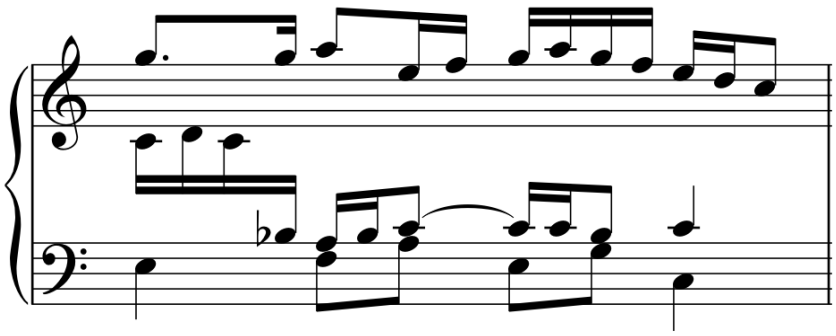
Example 31: BuxWV 136, m. 39, ex. “type 3b”



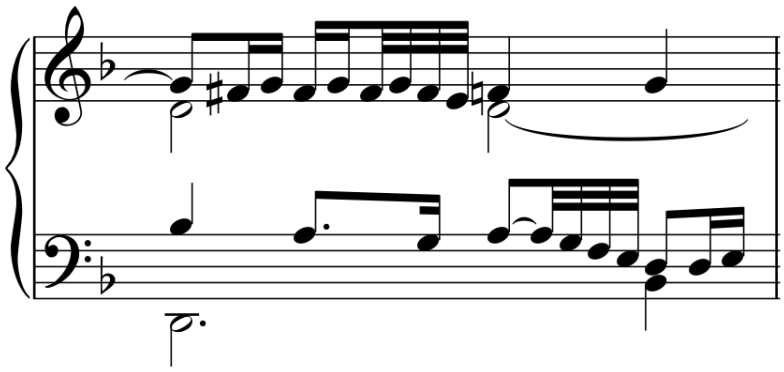
3c

Titled “quasi-augmented unisons,” this type does not use the characteristic horizontally hashed cells, but rather the diagonal shading of “type 1.” This category attempts to account for the similar audible issues raised in “type 3a/b” when a single, short duration note is placed as a buffer between what could have been an augmented unison. Obviously, this could easily be glossed over and considered a “type 1,” but every effort should be made to capture these instances since they are audibly different.

Example 32: BuxWV 136, m. 59, ex. “type 3c”



Example 33: BuxWV 140, m. 63, ex. “type 3c”

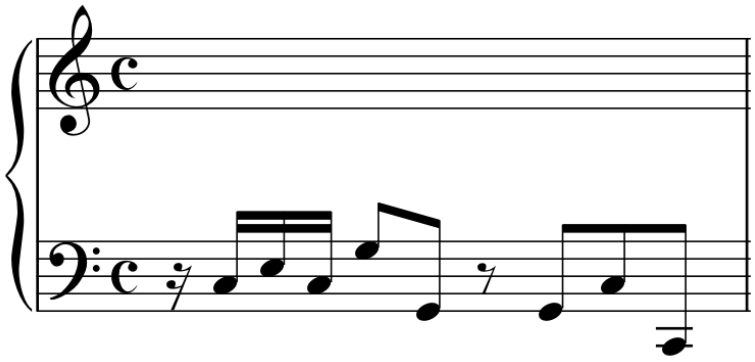


4

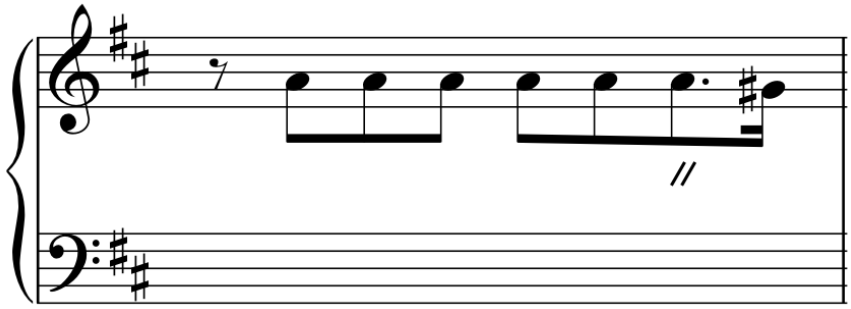
“Type 4” has no sub categories and is used infrequently. It functions in the numerical data as “type 6,” but looks quite different. Titled “exclusion of pitch for rhetorical gesture,” it attempts to capture measures where pitch material is intentionally excluded from typical row continuation, not for pivoting or individual chords, but powerful or intentional rhetorical gestures. Admittedly, this category lacks the kind of definitiveness that the other categories have. “Type 4/6” might better be combined with each other. Or, perhaps, the implied pitches of “type 6” could be given number in the data while “type 4” remains at zero or empty. Single chords could be given a “type 4” subcategory and rhetorical gesture could become another subcategory. Either way, there is some significant refinement and improvement to be made.

For now, one will find that it is used quite infrequently except to account for pitches in fugue subjects. If nothing else, this dotted shading can be used as a formal locater. For details on row saturation, see Appendix 4.

Example 34: BuxWV 137, m. 1, ex. “type 4”



Example 35: BuxWV 139, m. 21, ex. “type 4”



5

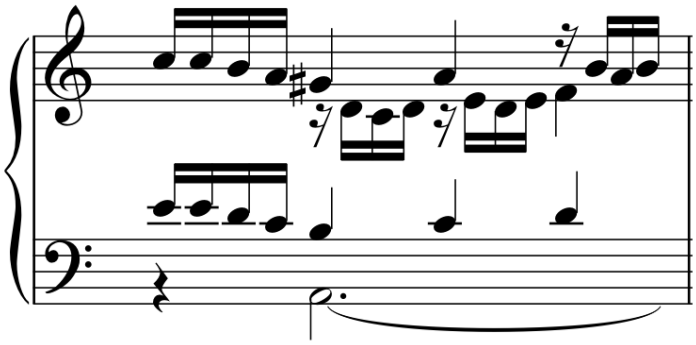
“Type 5” measures account for the only usage of solid black cells. These measures include at least two simultaneous notes that cannot be in tune in meantone. These notes, if separated by fifths, span more than the diatonic saturation of six fifths. They most obviously manifest themselves through occurrences of a sharp and flat note sounding simultaneously, though they hide themselves in other ways.

The subcategories are easily distinguishable in Figure 6. The letters determine the severity of offense, so by how many fifths, six is exceeded. There are no occurrences of “type 5a” or “type 5d” in the literature analyzed, but they were included here for theoretical clarity. “5a type” would involve the simultaneous occurrence of a pitch and its own chromatically altered partner. “5d type” would involve the occurrence of an augmented sixth chord and also does not

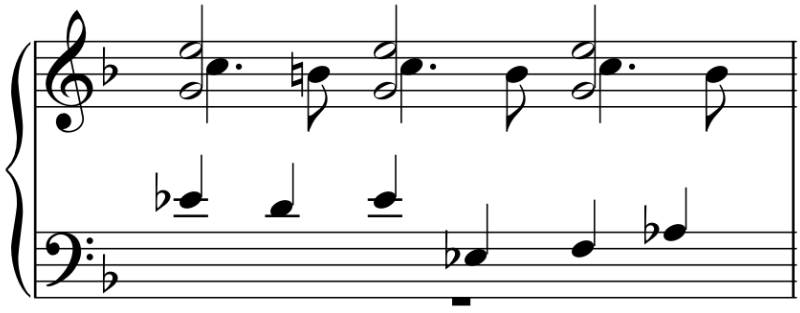
appear in the analyzed literature. The tacked on numbers indicate the severity of an offense. A "1" indicates a negligible offence, something that is hardly audible. Often this manifests itself as a simple neighbor tone or something with a short durational value. A "2" indicates an offense of some severity, something quite audible and sustained.

Pitches that do not actually sound as they are written (pitches that do not exist in meantone tuning) and therefore sound consonantly with the opposite pitch are blackened anyway. One should keep in mind that black cells in the split-key area or outside altogether might sound consonant. These occurrences seem to occur in key areas that are not generally supported by meantone anyway. If transposed to another key, they would indeed sound dissonant.

Example 36: BuxWV 137, m. 70, ex. "type 5"



Example 37: BuxWV 149, m. 149, ex. "type 5"



6, General

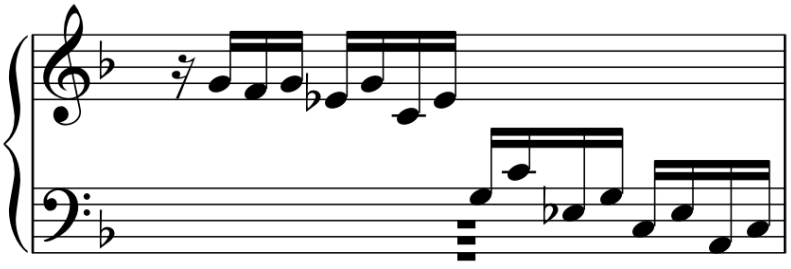
"Type 6" measures lack some central diatonic pitch material. Usually, there is no particular reason that this is the case other than a relatively slower harmonic rhythm that the temporal unit fails to capture. For the sake of this graphing system, it is necessary not to simply leave these cells blank. It is, however, important that these gaps be acknowledged both in the numerical data and graphical representations. This gap is always acknowledged by the presence of a light grey cell. The grey cell implies the presence of the lacking pitch.

As was acknowledged above, this system lacks a satisfyingly firm difference between "type 6" and "type 4." Some ideas for further refinement are given above in the discussion of "type 4." For a thorough understanding of gaps and acceptable excluded pitch material, refer to Appendix 4.

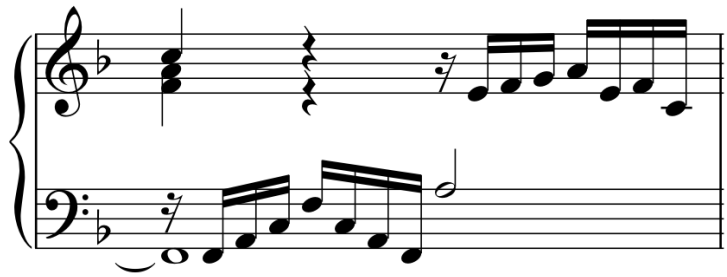
6a

"Type 6a" actually covers two very different but standard occurrences. The first is filling two cells in-between the pitches of a chord when a measure contains only a single chord. This occurrence is simple enough that no musical examples are provided below. This occurrence is easily recognizable in a graph: the second occurrence is also easy to recognize if looking vertically. An interrupted row is filled in based a context or existence of that pitch in both surrounding measures.

Example 38: BuxWV 149, m. 156, ex. "type 6a"



Example 39: BuxWV 145, m. 3, ex. “type 6a”



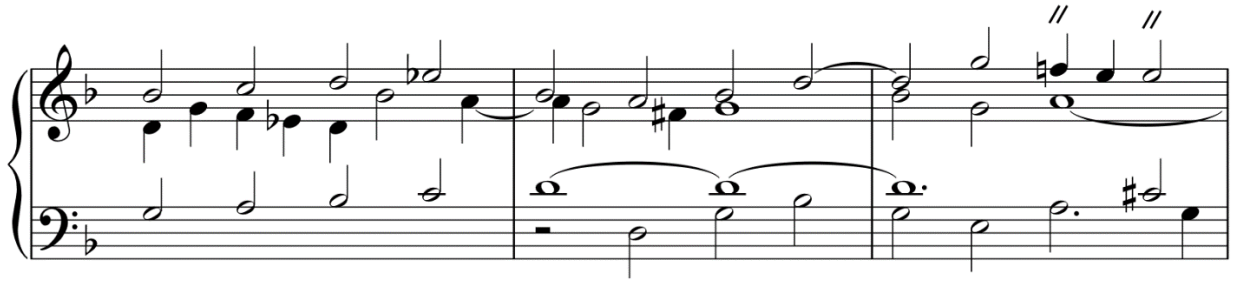
6b-1 and 6b-2

Both of these types require some interpretation since both require shading without context on both sides. “Type 6b-1” requires shading based on a forward looking context while “type 6b-2” looks back a measure. As with “type 1a” versus “type 1c,” “type 6b-1” should be favored over “type 6b-2” if there is ambiguity, but of course either can be chosen if the analysis clarifies some particular feature. These interpretations do not affect the numerical data.

6c

This type involves the decision to leave a cell blank. Almost always, this gap can be filled with context from some direction, but if the gap continues for an extended period, it is acceptable to leave a cell blank. This gap acknowledges with much greater emphasis that the pitch is lacking and is done so quite purposefully.

Example 40: BuxWV 149, mm. 30 to 32, ex. “type 6c”

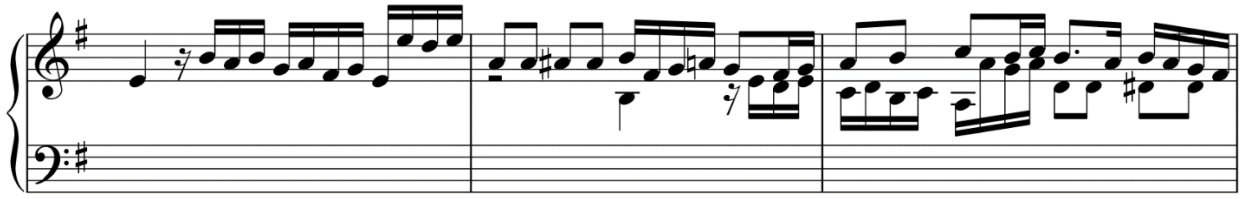


6d

“Type 6d” occurs least frequently. This pitch implication must happen with no context to achieve acceptable patterning. This pitch material is not excluded as “type 6c” since it is only a

very short duration and is not included in a pivoting gesture. It should clarify a shifting motion in the graph, but, again, since the numerical data is unaffected, it is not overstepping an analyst's bounds. See measure 18 of BuxWV 142.

Example 41: BuxWV 142, mm. 17 to 19, ex. "type 6d"



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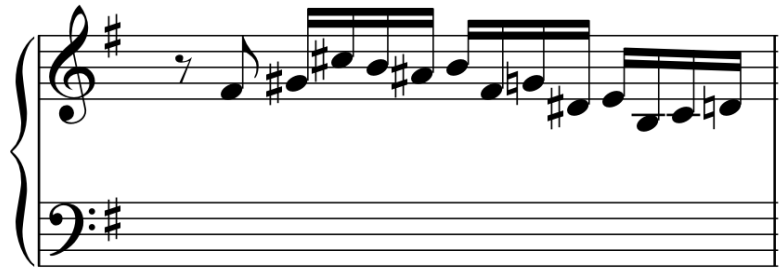
This "type *" coding should only be used as an absolute last resort. It might be most useful in particularly chromatic, active passagework. The excluded pitches are noted in the graph as well as the type column. Obviously, if pitches are dissonantly harmonized, they must be accounted for in "type 5."

Example 42: BuxWV 142, m. 101, ex. "type *"



Appendix 4: Explanations of Necessary Graphic Unification Rules

If a graph was filled in based solely upon active pitches in each temporal unit, the analyst would not be needed. Moreover, the graph would fail to show what was really happening. Two things come from attempting to reconcile this smattering of pitch material: (1) the "type" codings discussed above and (2) the definitions of row length discussed below. The row is defined as one temporal unit (usually one measure).

Leaving cells blank: Major vs. Minor

Before discussing issues of row length, it is important to establish a way to cope with pitch material in minor. Melodic minor creates raised pitches that are foreign to a typical diatonic set. Usually more than six stacked fifths result in dissonant intervals (or pitches outside of a diatonic collection), but ascending melodic or harmonic minor results in altered pitches that are simply replaced. Though certainly the exception, they could be harmonized with dissonant pitches which would be accounted for by "type 5" black cells. These considerations result in a simple rule: in major there should be no gaps, while in minor such blank cells are perfectly acceptable. There is no distinction between natural minor and major (see Appendix 6 for ideas about distinguishing tonal centers). This rule manifests itself most obviously by the easy recognition of minor versus major rows.

Acceptable Row Formations in Minor

Definitions of saturated and unsaturated diatonic rows in minor quickly become problematic, particularly if pitch material is excluded. Unsaturated rows are fine, but for visual clarity, and admittedly sometimes visual clarity alone, all unsaturated chromatically altered minor rows must reach hexachord status. This frequently forces the analyst to imply pitches using the "type 6" system. In other words, major passages may include unsaturated rows of any

length while unsaturated rows in minor must include six pitches. Again, the “type 6” system is not considered in the numerical data, therefore this rule is simply visual. All this is done to avoid distant floating pitches more than two blank spaces away. Figure 8 demonstrates a way to conceptualize saturated row formations in minor. All three passages are in D minor. The first contains only the C sharp, while the second contains both C sharp and B. The third row is included to capture instances where a secondary dominant is used while still being grounded in the original key, hence the F natural. In this case, the black arrow demonstrates the alteration of the leading tone of the secondary dominant. Figure 9 demonstrates a way to conceptualize the unsaturated row formations in minor. The arrows demonstrate the pitch being reinserted into its unaltered, continuous row. Figure 10 illustrates one of many possible problematic unsaturated formations and its alteration using “type 6” shading to standardize the visual product.

Figure 8: Acceptable Saturated Row Formations in Minor

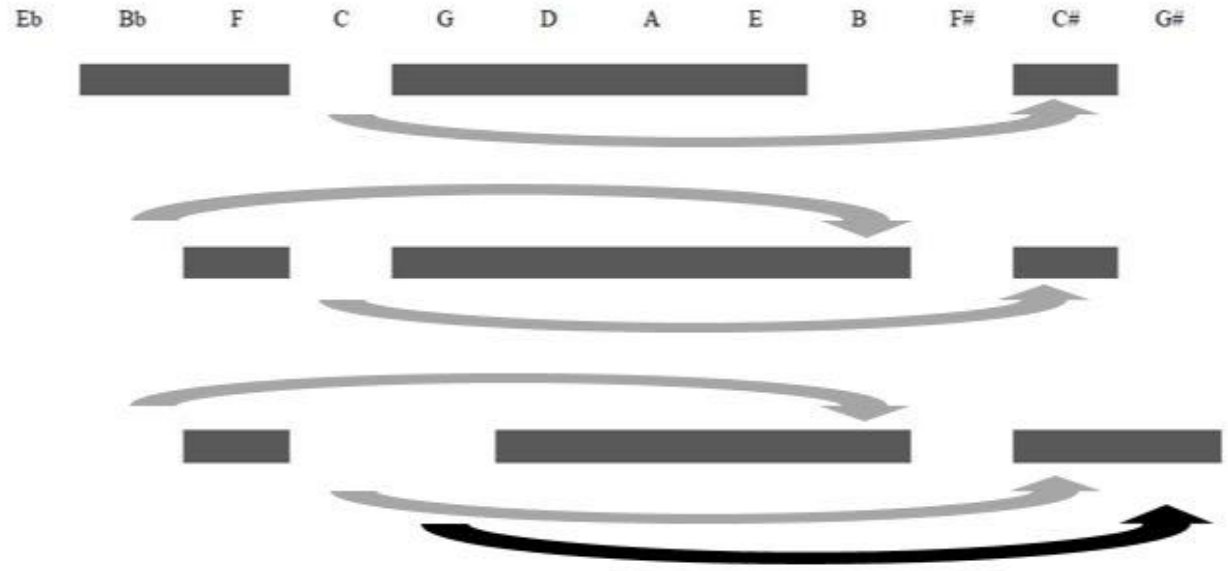


Figure 9: Acceptable Unsaturated Row Formations in Minor

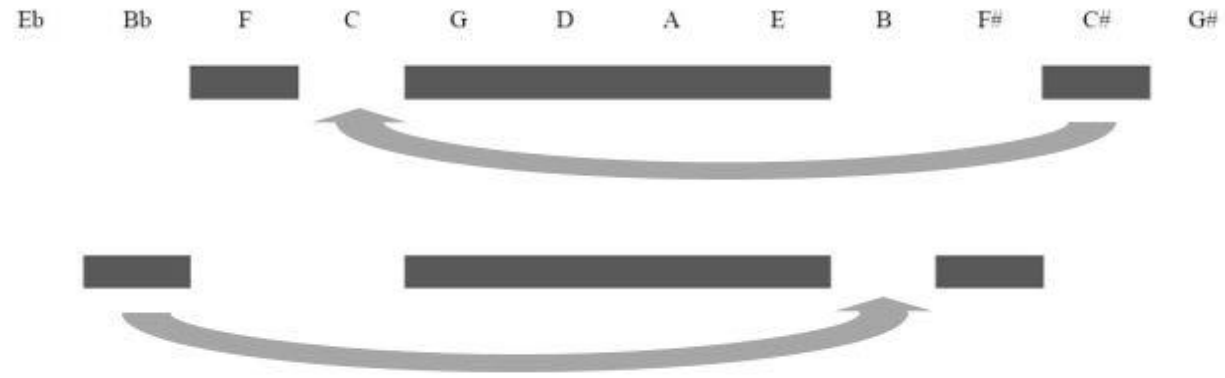
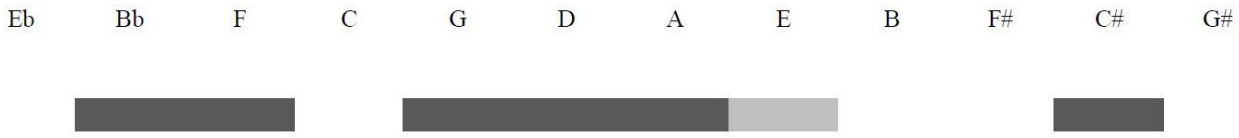


Figure 10: Example "Type 6" Correction in an Unacceptable Row Formation in Minor



Appendix 5: Extraction of Numerical Data

The data accounted for in each graph comes from two different number assignment systems which can be called (1) the weighted cell system, and (2) the unweighted positive/negative system. Each system hopes to enlighten different trends in regard to each piece.

The Weighted Cell System

Out of the two systems, the weighted cell system is significantly more arbitrary. That being said, a lot of useful, enlightening data can be extracted using it. In this system, all shaded cells are assigned a number except for dotted and light grey cells. The dark grey and black cells (i.e. the cells of greatest weight) are assigned the value of 1. The diagonally shaded cells are assigned the lowest value of .33, a close equivalent to 1/3. The horizontally hashed cells are assigned .66, a close equivalent to 2/3, so that they are weighted more. This weight decision was based solely on the peculiar audible issues that arise with augmented unisons.

The simplest calculation is the pitch column activation averages. This is very simply the average of active cells in each column. To do this one must add all data together in each column and divide it by the number of temporal units (inclusive of split measures).[80] At a glance, after converted to percentages, it is now possible to see the percentage of temporal units that each particular pitch was activated in. This number is, by definition of the numbering system, weighted to take into account the relative importance of a pitch in a certain context.[81] These calculations can be found in Appendix 1 at the bottom of each piece.

Another piece of data that can be extracted from this numbering system is the activation number of cells in columns on the exterior edges of meantone. First, by simply counting the

[80] This decision was made hesitantly, but with the fact that split units are usually particularly active with differing pitch material in mind. Essentially, the split measure "earned "a place as two separate units.
[81] It would also be interesting to have a third, binary numbering system that was unweighted to get an unweighted percentage for column activation.

number times the notes A flat, D sharp, or A sharp are activated, since they may be accounted for by split keys or common forms of modified meantone. Then, counting the number of times the pitches G flat, D flat, E sharp, and B sharp (and others if they exist) since these represent an outright exit from the boundaries of even modified meantone. Finally, a third column totals both of the others. As should probably be the case in a meantone composition, the majority of the numbers will amount to zero. This number, though derived from a weighted system, is unweighted since it simply counts data. In the totals/averages located in Appendix 2, there are three calculations: (1) the number of active cells in each particular category, (2) the number of temporal units that had activated at least one pitch in a category, and (3) the percentage of temporal units that contain each category of pitch. The latter two are so relevant because it is not just the number of actual offending pitches, but how the composer utilizes them. It appears that with at least some frequency that offending pitches are used in quick succession, so that a temporal unit may contain a couple offending pitches, but the very next unit (or even the whole piece) may contain no other offending pitches.

In the next column is a calculation titled row width. Row width is the addition of all data in each temporal unit. This calculation is the primary reason that a weighted system was necessary. As has been established, the standard row length should be seven (six stacked fifths). Given that same rows can have as many as three extra pitches, it seemed that a row length of nine was excessive and failed to demonstrate or capture function and hierarchy. So, a weighted length was established. This regularizes row length and downplays extreme instances that rarely change the sonic effect of the measure. It also makes the occurrence of different numbers somewhat recognizable. For instance, a 7.33 is likely a regular row of seven pitches attached to a diagonally shaded cell. It is less likely, yet possible, that it could be a row of six pitches attached

to something like two horizontally hashed cells. Though this is still guess work, it is significantly more telling than an unweighted number. The row width change column is the difference between the row width of the previous temporal unit and row width of the current one. A positive number would indicate a row length that grew, while a negative number would indicate a row that had shrunk. The average change numbers in Appendix 2 averages the absolute value of the width change column. High growth and high shrink numbers indicate the extremes in each direction of row width change.

The Unweighted Positive/Negative System

The second of the two systems yields less data, but creates a way to locate the left/right or flat/sharp placement of a row. To do this, each pitch column is assigned a number. Since D is the center of the tuning system, it was assigned the number zero. All fifths going up from there are assigned a whole number rising from there (1, 2, 3, etc.). All descending fifths are assigned a whole number lowering from there (-1, -2, -3, etc.). Now, each cell that has any kind of shading other than light grey or dotted receives the number assigned to that particular column.

The average of each row now yields the data located in the R-L row placement column. This number can be interpreted as the approximate diatonic center of each row given the key that D is zero and numbers are dispersed from there. The way all music functions is that if the center of a stack of six fifths is D (the number zero), the row is likely in C major or A minor. The result from this equation, if in a stack of six fifths, is the number of the second scale degree in major, or the fourth in minor. The problem is that this kind of identification is not universally possible; for instance, the spaces in an interrupted ascending melodic or harmonic minor row skew data. In the end, this number is not a substitute for looking at key of the music itself, but can easily function as a locator of relative row motion toward the flat or sharp side. The degree of change

column is meant to indicate rate at which a row moves left or right on the graph. It is simply the absolute value of the difference between the previous and current cells. The averages at the bottom of each column then respectively indicate the average center of all units for the piece[82] and then more interestingly the average change of distance right or left for the piece.

[82] The tonal center, as above, could again be deduced by using this number.

Appendix 6: Other Graphic Ideas

The Unsatisfying Loose Ends of a Prototype System

Several issues in regard to the graphic system have been discussed through the course of this paper. The dotted ("type 4") and light grey ("type 6") currently leave much to be desired and should be significantly refined if this graphic system were to be further investigated. Ways of dealing with saturated versus unsaturated and interrupted but continuous rows (ascending melodic and harmonic minor) should be handled less arbitrarily. This problem serves as an extension of problems with "type 6" shading. Firmer rules regarding floating blocks could be established in general. The coding numbers themselves are a product of a system that developed in time. Now, with more information, they could also be revised and sharpened for easier use. The conclusions drawn at the end of Part Three should be consulted for further ideas.

Acknowledging the Tonal Center

Though it is possible to make a hypothesis as to the tonal center of a row, there is no definitive way to talk about a tonal center without consulting the score. The shading system used throughout this document could be expanded. Another shading or notation could certainly be used throughout each graph to illustrate a tonal center. If deemed important enough, these centers could weigh more in the data. Tonal centers were considered less important than other issues in the goals of this document. Furthermore, tonicizations can blur structural moments, which can leave many interpretations open to debate. For these reasons, tonal center shading was tabled.

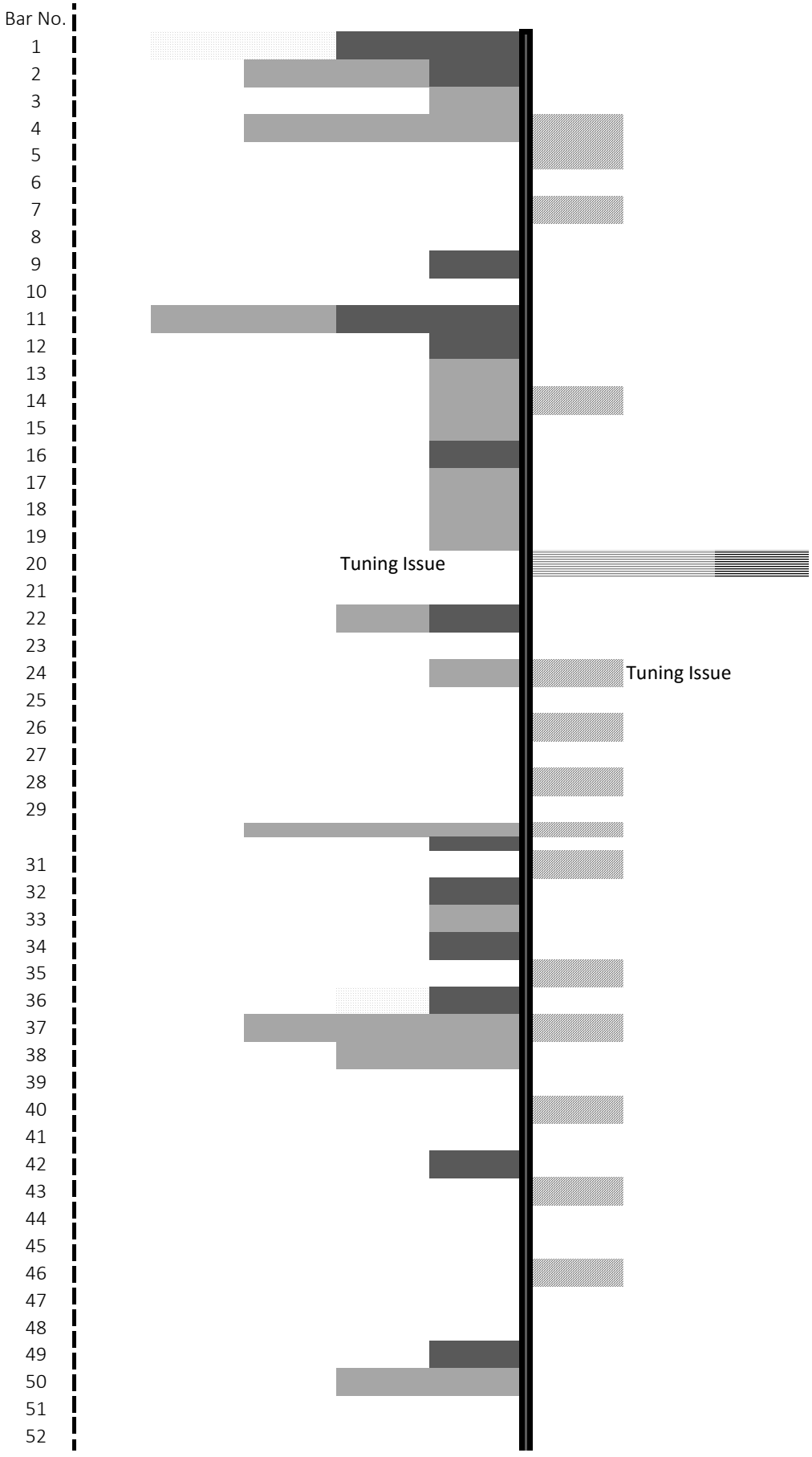
Related to the idea of notating shifting tonal centers throughout a piece, it might also be interesting and fruitful to highlight the piece's overall tonality somewhere other than the title. This could be done easily by highlighting the entire column, allowing one to easily see there the

piece shifts away from this center. Perhaps the best way would be to add borders to either side of the column in question.

DNA Style Graphs

Though this document has been limited to a single form of graphic representation, there are certainly other potential methods of graphing. The widest range of representations would, of course, lead to the highest degree of enlightenment. A prototype graph of BuxWV 137 (C Major) is given below in a very different format. In the graphs utilized throughout this document, there have been fixed points; these fixed points manifest themselves as columns assigned to single pitch classes arranged in fifths, and, on the outer edges, boundries for meantone tuning are illustrated. What if those boundaries were removed—what if the goal posts were movable?[83] Such is the case below. The graph illustrates row length rather than a row's exact place in fixed space. All shadings were simply transferred. The right half of the graph indicates a row that extends beyond the convential six fifths while the left half indicates shortcomings, or rows that do not contain all seven pitches. "Type 4/6" cells always appear on the left while "type 1/3" cells always appear on the right. "Type 5" cells were capturable less than half the time, so it was simply noted that a tuning issue had occurred. Obviously if this graphing system were ever to be pursued, it would need to be significantly refined. It remains to be seen if any useful information could be uncovered this way. If nothing else, removing the fixed points enables one to better see shifting between over-saturated, saturated, and unsaturated rows.

[83] For a particularly effective graphic analysis in this vein see Scott Murphy, "A Composite Approach to Ives' "Cage"," *Twentieth Century Music* 5/2 (September 2008), 187 and 192.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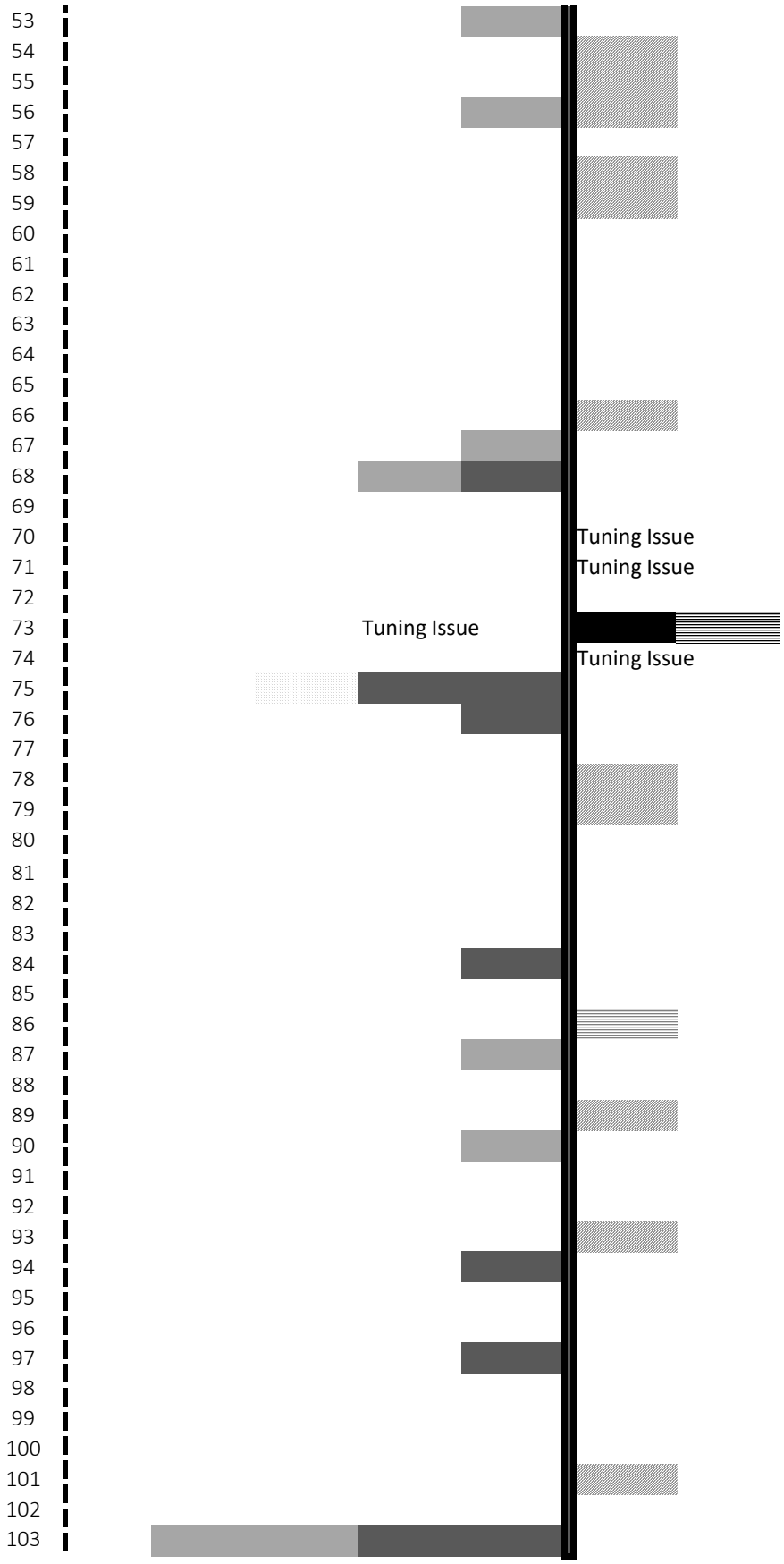
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